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OF THE

State of Pennsylvania,

FOR THE

PROMOTION OF THE MECHANIC ARTS.

DEVOTED TO

MECHANICAL AND PHYSICAL SCIENCE, CIVIL ENGINEERING, THE ARTS
AND MANUFACTURES, AND THE RECORDING OF AMERICAN
AND OTHER PATENTED INVENTIONS.

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TREATISE

ON

PLANE AND SPHERICAL TRIGONOMETRY,

BY W. CHAUVENET, A. M.,

PROFESSOR OF MATHEMATICS IN THE U. S. NAVAL ACADEMY, (ANNAPOLIS, MD.)

In One Vol. 8vo.

Published by Henry Perkins, No. 22 South Fourth Street, Philadelphia.
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and by the booksellers generally.

Professor Chauvenet's reputation as a mathematician, was a sufficient guaranty to the publisher that his work would be found to be a thorough and scientifically digested treatise. But it is not often that with this scientific excellence we find a power of adaptation to the wants of students, and the convenience of the teacher.

Professor Chauvenet has, it is believed, entirely succeeded in the difficult task of combining the features of an elementary *text-book* with those of a complete and thorough *manual.* The elementary matter is printed in a larger type, and may be regarded as a sufficient course for the *average* of college classes; while the higher deductions, in smaller type, may be reserved for the more proficient student, or deferred until he finds occasion for their use. The student who has used this as his text-book in college, has no need afterwards to look abroad for other works on Trigonometry to enable him to prosecute his mathematical studies. Every one will appreciate the advantage of thus connecting the higher portions of the subject, in their proper order, with those fundamental considerations upon which they immediately depend.

From the ASTRONOMICAL JOURNAL, (*Cambridge, Mass.,*) VOL. 1, NO. 13.

"The newly published Treatise on Plane and Spherical Trigonometry, by Professor CHAUVENET, has induced me to depart from the ordinary rule of the *Astronomical Journal*, the province of which, does not include notices of new works, except in extraordinary cases. Professor CHAUVENET has endeavored to furnish a manual of Trigonometry which shall include the latest advances made in that department of mathematics, and be worthy of adoption as a standard. In this work he has rendered a service to good science. The consideration of the Gaussian formulas, and of the 'general spherical triangle,' a full discussion of the Gaussian Tables of Logarithms for addition and subtraction, and an elegant discussion of the differences and differentials of triangles, are among the improvements upon CAGNOLI's treatise, which the progress of science during the last forty years, has enabled Professor CHAUVENET to make." G.

From the AMERICAN JOURNAL OF SCIENCE AND ARTS, (*New Haven,*) *September*, 1850.

* * * * "A complete and well arranged treatise of Trigonometry, has been greatly needed for the use of mathematical teachers, and of practical astronomers, surveyors, engineers, &c. No work of this kind has before been published in this country; and we know of no English work in which the subject of Spherical Trigonometry especially, is presented in a satisfactory manner. Many useful formulæ now commonly employed in astronomical investigations are not to be found in the larger and more recent treatises of Trigonometry published in England. These deficiencies are well supplied in the work of Mr. CHAUVENET; and from the examination we have been able to make, we are satisfied that it will prove a more convenient and useful manual for the mathematical teacher and the practical mathematician, than any similar English or American work." * *

From the JOURNAL OF THE FRANKLIN INSTITUTE. (*Philadelphia.*) VOL. XX., NO. 3.

"This work is an important addition to our mathematical literature, being the most complete treatise on Trigonometry extant in the English language. * * * Treatises on this branch of mathematics, are sufficiently numerous to make any addition to their number a work of supererogation, unless it has some distinctive features of excellence. Of these, Pro fessor Chauvenet's book has not a few. Among them, we instance th introduction of the Gaussian equations, which are wanting in all the tex books used in our schools; of the finite variations and differentials of triangles; of the solution of the general spherical triangle according to Gauss, and the general development of the sines and cosines of multiple angles in series, according to Poinsot. * * * *

"The only subject we have missed in Professor Chauvenet's treatise, is the development in series of the differences in the spherical triangle, in which two sides and the included angle are given, where one of the sides is very small, a case of constant occurrence in geodesy. With this little exception, the book leaves nothing to be desired, and we doubt not, will rank among the most classical works on pure mathematics."

From the Christian Examiner, (*Boston*,) *September*, 1850.

"This is one of a class of books as yet rare in America, but of whic there is, fortunately, good promise for the future. Professor Chauvenet has furnished a work excellently adapted for use as a college text-book but he, nevertheless, had a higher aim. The volume before us is the most complete treatise on Trigonometry, with which we are acquainted in any language. The author has availed himself of the important labors of living mathematicians, and we here find valuable formulæ, which are not given in any other tolerably complete work on the subject known to us.

"In the original parts, Professor Chauvenet has added to his previou reputation, and we observe that the 'Astronomical Journal' has expressed a highly favorable opinion, in a special notice of the work."

JOURNAL

OF

THE FRANKLIN INSTITUTE

OF THE STATE OF PENNSYLVANIA

FOR THE

PROMOTION OF THE MECHANIC ARTS.

JULY, 1851.

CIVIL ENGINEERING.

For the Journal of the Franklin Institute.

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A New Method of Calculating the Cubic Contents of Excavations and Embankments.—By John C. Trautwine, C. E.

There is but one correct principle upon which to calculate the cubic contents of excavations and embankments; and that is, by means of what is known as the *Prismoidal Formula*, or Rule.

This Rule is as follows:

Add together the areas of the two parallel ends of the prismoid, and four times the area of a section half way between and parallel to them; and multiply the sum by one-sixth of the length of the prismoid, measured perpendicularly to its two parallel ends.

Since, in railroad measurements, the prismoids are generally 100 feet long, it becomes easier in practice to multiply the sum of the areas by 100, (by merely adding two cyphers,) and to divide the product by 6; which amounts to the same thing as multiplying their sum by $\frac{1}{6}$th of 100 feet.

The very general application of the prismoidal formula to other solids than such as are generally understood by the term "prismoids," has been shown by Mr. Ellwood Morris, Civil Engineer, in an able paper published in the Journal of the Franklin Institute. *Vol.* xxv, 2d Ser. *p.* 381.

It embraces all parallelopipeds, pyramids, prisms, cylinders, cones, wedges, &c., whether regular or irregular, right or oblique; together with their frustra, when cut by planes parallel to their bases; in a word, any solid whatever, which has two parallel ends, connected together by plane or unwarped surfaces.

In the cylinder and cone, the sides may be considered as consisting of an infinite number of indefinitely narrow unwarped planes. In railroad cuttings, it rarely happens that the ground surface lying between two consecutive cross sections 100 feet apart, is absolutely unwarped; yet, for practical purposes, it may very frequently be assumed to be so. When much warped, the cross sections must be taken closer together than 100 feet.

There are generally two circumstances under which it is necessary to ascertain the cubic contents on a public work; viz: first, after a preliminary survey of one or more *trial lines*, for the purpose of determining *approximately* their actual or comparative costs; and, second, after the final adoption and staking out of the determined route, in order to know *precisely* the amount of work to be done.

The measurements for the latter are performed with considerably more care, and attention to detail, than those of the former, inasmuch as upon them depend the payments to be made to the person who executes the work. They, moreover, involve considerations which cannot be attended to during a preliminary survey, without incurring an expenditure of time and labor, more than commensurate with the importance of the result.

When the ground is *level* transversely of the line of survey, there is no difficulty whatever in ascertaining the contents from a table of *level cuttings*, previously calculated; but when the ground is *inclined* or *irregular* transversely, the calculations have hitherto been attended with considerable labor.

The following method by diagrams, devised by myself during my probation as an assistant, and now communicated for the first time, will, I trust, be found to render the operations in the last cases nearly as simple and expeditious as in those of level ground; or, at least, infinitely more so than the usual ones. It dispenses with a great deal of calculation, and is, therefore, comparatively free from liability to error arising from that source.

The construction of the diagrams is extremely simple, notwithstanding that, at first sight, they appear somewhat complex. They are but few in number, since any particular road will generally require but three or four, which may be prepared by one person in a day. Before proceeding to explain the manner of drawing them, I will give one or two examples of their use, that the reader may see the object aimed at, and to what extent it is attained.

Example 1. Suppose that in a roadway of 28 feet wide, and with side-slopes of $1\frac{1}{2}$ to 1, the cutting at a certain station is 20 feet; and that the ground, instead of being level transversely, inclines at an angle of 15°.

Turn to the diagram for a roadway 28 feet wide, with side-slopes of $1\frac{1}{2}$ to 1: place a finger on the centre line, at the height of 20 feet, and run it along up the curved line which commences at that point, until it strikes the inclined line marked 15°. It will be seen at once that the two coincide at the height of 22·8 feet: *and this is the depth of the equivalent level cutting, which would have precisely the same area as the section under consideration.*

All such cases may therefore be instantly, and without any calculation whatever, reduced to others of *equivalent level cuttings.*

This constitutes the main feature of the principle involved in the diagrams.

Had the depth been 20·3, or other decimal of a foot, the proceeding would have been the same as with the 20 feet; and the equivalent level cutting would be found on the inclined line 15°, at the distance of ·3 of a foot (estimated by eye) above the curved line 20.

Example 2. Using the same diagram; let the depth of cutting be 2 feet, and the transverse slope of the ground 20°. Here, placing a finger on the centre-line, at the height of 2 feet, and running it along the curved line commencing at that point, it will be found that before reaching the inclined line of 20°, it encounters the dotted curved line drawn near the bottom of the diagram. When this occurs, we know that the ground-slope cuts the roadway, forming a cross section, partly in excavation, and partly in embankment, as in fig. 7.

This is a most useful check; for in such cases, the contents cannot be obtained by means of the diagram; but recourse must be had to a figure of the section, drawn for the purpose; as must also be the case when the ground is *irregular* transversely. A very simple method of proceeding, in all such cases, will be given further on.

I trust that what has been already shown, will satisfy the reader that my method partakes of utility, as well as of novelty.

On the page opposite each diagram, is a table of cubic yards for level cuttings, and for lengths of 100 feet. By means of this, the cubic contents may at once be taken out, when the equivalent level cuttings at both ends of a station are equal: but if they are not so, the prismoidal rule must be employed, thus:

Suppose the equivalent level cutting at one end to be 20 feet, and at the other 25 feet. Then, that at a point half way between them would be 22½ feet. Therefore, the cubic content will be equal to one-sixth of the sum of those corresponding to each of the two end depths, and four times that of the centre depth; that is,

Cubic content by table IX, for 20 feet depth = 4296 cubic yards,
" " " " " 25 " = 6065 " "
Four times " " " 22½ " } = 20584
or 4 times 5146
6)30945
Cubic yards contained in the station, = 5157·5

It will be perceived that, instead of the *areas* corresponding to the different depths of cutting, or heights of filling, our tables give the *cubic yards* corresponding to those areas, for lengths of 100 feet. For the purposes of calculating cubic contents, these solidities may evidently be used instead of the areas; but for such cases as require the areas themselves, a table of such is added. Its use will be shown further on.

I will here observe, that for mere *comparative* estimates of trial lines, the labor may be much reduced by taking from the tables, the cubic content corresponding to the *average* of the equivalent level cuttings at the two ends. This mode is, of course, by no means mathematically correct, and should never be resorted to for final estimates; but it will frequently be sufficiently approximate (always a little deficient) for such trapezoids as occur in ordinary cuttings and fillings, where the depths at the two ends differ but a few feet.

For instance, in the foregoing example, the correct contents of the station 20 feet deep at one end, and 25 feet at the other, were found to be 5157·5 cubic yards; while by this approximating mode, the contents of an *average* equivalent level depth of $22\frac{1}{2}$ feet, would be 5146 cubic yards; or but $11\frac{1}{2}$ yards less than the truth.

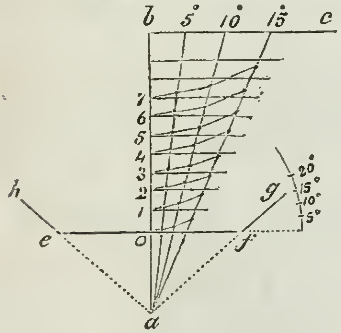
In this manner, an entire cut or fill may be approximately estimated at one operation, by merely adding together all the average midway equivalent level cuttings or fillings, and dividing their sum by their number for an average one.

Thus, if the average midway equivalent level depths of 6 consecutive stations of cuttings, were respectively 2, 5, 6, 4, 3, 7 feet, an average depth might be taken of $\frac{2+5+6+4+3+7}{6} = 4{\cdot}5$ feet; and the cubic contents taken from the proper table, for a depth of 4·5 feet, and multiplied by 6, (the number of stations,) would give the contents of the whole 600 feet, but slightly too little.

I will now proceed to describe the mode of preparing the diagrams, for any width of roadway, and for any side-slope whatever.

The determination of the *principle* on which they are formed, is left as a problem for such of the younger members of the profession as may choose to exercise their ingenuity upon it.

Fig. 1.



Draw a vertical line *a b*, fig. 1, of any given length at pleasure. (One foot decimally divided; or $12\frac{1}{2}$ inches, divided into $\frac{1}{8}$ths of an inch, or 10 inches divided into $\frac{1}{10}$ths of an inch, will generally be found convenient.) Call the length of this line unity, or 1. It represents the usual centre-line of levels, or of cuttings and fillings.

From the upper end of this line draw *b c*, at right angles to it; and from *b* towards *c*, lay off and number the distances *b*5°, *b*10°, *b*15°, &c., contained in the following table; using as a scale, the length *a b*, as 1 or unity, divided into tenths and hundredths.

For example, if the side-slopes *h e*, *g f*, of the excavation or embankment, are $\frac{1}{4}$ to 1, lay off (without any regard to the width of roadway,) the distances on the upper column of the table; if 1 to 1, those on the 2nd column, &c. This done, the scale of *a b*, *as unity*, will be of no further use.

Distances on *b c*, intermediate of those in the table, may be inserted with sufficient accuracy by eye.

Those beyond 20° will rarely be required, because, when the transverse ground-slope is great, retaining walls are resorted to as a matter of economy.

Table of Distances from b, *to be laid off on the Horizontal Line* b c, *Fig.* 1.

Side Slopes.												
¼ to 1, or 78° 58′	10° ·005	20° ·011	25° ·014	30° ·017	35° ·022	40° ·026	45° ·032	50° ·038	55° ·016	60° ·057	65° ·073	70° ·099
1 to 1	5° ·044	10° ·089	13° ·117	15° ·136	18° ·167	20° ·188	23° ·222	25° ·247	28° ·288	30° ·318	33° ·369	34° ·388
or 45°	35° ·409	36° ·431	37° ·454	38° ·480	39° ·510	40° ·543						
1¼ to 1	5° ·068	8° ·108	10° ·138	13° ·181	15° ·214	18 ·264	20° ·300	23° ·358	25° ·401	28° ·476	30° ·530	32° ·600
or 38° 40′	34° ·685											
1½ to 1	5° ·097	8° ·158	10° ·201	13° ·267	15° ·314	18° ·390	20° ·445	22° ·506	24° ·574	25° ·611	26° ·652	27° ·696
or 33° 42	28° ·747											
2 to 1,	3° ·106	5° ·175	8° ·285	10° ·363	11° ·404	12° ·447	13° ·489	14° ·533	15° ·580	16° ·629	17° ·683	18° ·739
or 26° 31′	19° ·798	20° ·865	21° ·936	22° 1·017	23° 1·110							

From the different points *b* 5°, *b* 10°, *b* 15°, &c., (and from the subdivisions of single degrees between them, as in the working diagrams,) draw lines to *a*. From *a* upwards set off, by any scale at pleasure, (from $\frac{1}{12}$th to $\frac{1}{8}$th inch to a foot will be found convenient,) the distance *a o*, which is the height of the triangle *e f a*, formed by the prolongation of the side slopes *g f*, and *h e* to *a*; *e f* representing the width of the roadway, whatever it may be, on the same scale.

It is not necessary actually to draw *h a*, *g a* and *e f*, as we may set off *a o*, by recollecting that if the side-slopes are

¼ to 1, then *a o* will be 4 times *e f*, or width of roadway.
1 to 1, " " equal to *e f.*
1¼ to 1, " " ·8 of *e f.* × should be ·8f
1½ to 1, " " ⅔ of *e f.*
2 to 1, " " ½ of *e f.*

Beginning at *o*, divide the vertical or centre line *o b*, by the same scale into feet, numbering them 1, 2, 3, &c., from *o* upwards; and from the points of division 1, 2, 3, &c., draw horizontal lines parallel to *b c*, as shown in fig. 1.

From *o* as a centre, lay off with a protractor, the several angles of transverse ground-slope as shown by the dotted arc in fig. 1. As before remarked, angles higher than 20° will seldom be required.

Note.—In fig. 1, the inclined lines, and also the angles on the dotted arc, are, for convenience, numbered only for every 5°; but in a *working* diagram they should be taken nearer together, for instance every, 2° to 3°.

Lay a parallel ruler from *o* to 5° on the dotted arc, and mark with a dot the point of intersection on the inclined line *a* 5°; then keeping the ruler in the same position, move it upwards along *o b*, stopping at every division of 1 foot, and making corresponding dots on the inclined line *a* 5°, as in fig. 1, continuing to such a height on the centre line as will include the greatest cutting or filling to be calculated by the diagram.

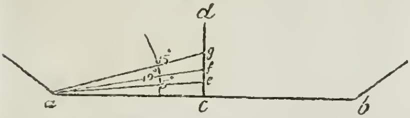
Then lay the parallel ruler from *o* to 10° on the dotted arc, and mark with a dot, the point of intersection on the inclined line *a* 10°; then keeping the ruler in the same position, move it upwards along *o b*, stopping at every division of 1 foot, making corresponding dots on the inclined line *a* 10°.

Then lay the parallel ruler from *o* to 15° on the dotted arc, and proceeding as before, make corresponding dots on the inclined line *a* 15°, and so on up to as high an angle as will equal the greatest transverse slope of the ground which occurs on the work to be calculated by means of the diagrams.

Finally, connect the corresponding dots on the several inclined lines, forming thereby a series of curves, as shown in fig. 1, and also in our working diagrams. The diagram is now ready for use, for all cases of ground-slope which do not intersect the roadway, thereby forming a section partly in excavation, and partly in embankment, as shown in fig. 7.

In order that the diagram itself may inform us when this is the case, the dotted curve shown near the bottom of the working diagrams is added. It is prepared as follows:

Fig. 2.



Let *a b*, fig. 2, represent the width of roadway, and *c d* the centre line of cuttings and fillings. From *a* as a centre, lay off with a protractor, the angles 5°, 10°, &c., and draw the lines *a e*, *a f*, *a g*, &c., to the centre line.

Now, suppose the height *c e*, corresponding to 5°, to be 2 feet. Mark on the working diagram, the intersection of the *curved* line of 2 feet with the inclined line of 5°. Suppose the height *c f* corresponding to 10° to be 4 feet; and mark on the diagram the intersection of the curved line of 4 feet with the inclined line of 10°; and so on with the rest. Then join their several marks of intersection, and the dotted curve is formed, and the diagram is finished.

The working drawings which I have given, are on a scale of $\frac{1}{10}$th of an inch to a foot, for convenience of insertion in this volume; yet, although the curved lines are drawn straight across several divisions of the inclined lines, (generally 5 of them,) they will rarely be found, in operating with them, to differ as much as $\frac{1}{10}$th of a foot from the truth.

They are adapted to such widths of roadway as I judged most likely to be adopted in ordinary practice; viz.: for single and double track embankments, 14 and 24 feet wide on top, and with side slopes of $1\frac{1}{2}$ to 1; and for single and double track excavations, 18 and 28 feet wide at bottom, with side slopes of from 1 to 1, up to 2 to 1.

The widths will rarely differ more than 2 feet from those for which the diagrams have been prepared. The most mistaken economist would hardly venture to make them more than 2 feet less; nor do I conceive that any advantage would attend making them more than 2 feet greater.

It is sometimes advisable to increase the quantity of excavation to be taken from a cut, in order to furnish earth for an adjoining embankment. When the value of land is not sufficiently great to constitute an objection, this may generally be most advantageously effected by merely increasing the side-slopes of the cut to 2 to 1; but, where that would not be sufficient, it becomes necessary to increase the width of the cut at bottom also, and separate calculations must be made for the purpose.

No diagrams accompany the tables of level cuttings for side-slopes of ¼ to 1, which are used only for rock; because with this side-slope, the transverse inclination of the ground rarely affects the quantity of material to an important extent. Still, on every work on which much rock cutting occurs, a diagram should be prepared for the purpose.

Should other widths of roadway be adopted, new diagrams must be drawn for them; as also new tables of level cuttings calculated.

These new tables may be easily made by merely adding to or subtracting from the contents corresponding to every consecutive $\frac{1}{10}$th of a foot of depth in the tables of level cuttings, an additional ·741 of a cubic yard, for each 2 feet of width added or subtracted.

For example, suppose that the roadway, instead of 28 feet, is to be made 30 feet wide; with side slopes of 1½ to 1. Here,

The Cubic Yards for a 28 feet Roadway are by the Table,		By the continual addition of ·741 of a Cubic Yard, we obtain,	Cubic Yards in a 30 ft. Roadway; equal to the sum of the two preceding columns,
Depth in feet.	Cubic Yards,		
·1	10·4	·741 ·741	11·1
·2	21·0	1·482 ·741	22·5
·3	31·6	2·223 ·741	33·8
·4	42·4	2·964 ·741	45·3
·5	53·2	3·705 ·741	56·9
·6	64·2	4·446 ·741	68·6
·7	75·3	5·187 ·741	80·5
·8	86·5	5·928 ·741	92·4
·9	97·9	6·669 ·741	104·6
1·0	109·3	7·410	116·7

Had the new roadway been 26 feet wide, instead of 30, the middle column would have been *subtracted from* the first, in order to form the third one.

It is not absolutely necessary to calculate new tables of level cuttings for widths differing 2 feet from those which I have assumed in the working diagrams. The contents of an excavation or embankment, may be taken from the nearest table, by means of the equivalent level cuttings deduced from the diagrams; and an allowance be made afterwards for the 2 feet difference of width, by adding together all the depths, and dividing their sum by their number, for an average depth. The number of cubic yards taken from table 14, for this average depth, and a width of 2 feet, will, when multiplied by the number of 100 feet stations in the cut or fill, be correctly the amount to be added to, or taken from, the quantity previously obtained from the tables.

While the width of roadway remains the same, a separate diagram is required only for each side-slope; so that when the roadway has the same width in cuttings, and on embankments, with side-slopes of $1\frac{1}{2}$ to 1 in both, but one diagram is necessary for the entire road.

But, generally, the roadway is wider in the cuts than on the embankments; requiring at least one diagram for embankments, with side-slopes of $1\frac{1}{2}$ to 1, and one for excavations, with such side-slopes as may be adopted.

Frequently one will be required also for rock cuttings, of ~~$\frac{1}{2}$~~ 1/4 to 1; and if different side slopes of excavation are employed in different kinds of soil, a diagram must be prepared for each side-slope.

An entire set for any particular road, may be completed by a ready draughtsman, in a day.

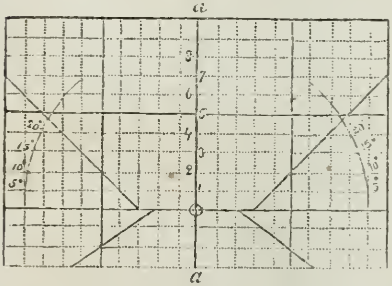
Cases of Ground Irregular Transversely.

All cases of irregular transverse ground-slope, (except that in which the ground-slope intersects the roadway, as in fig. 7,) may easily be reduced, by drawings, to such a form that their equivalent level cuttings may be obtained by means of diagrams, and the corresponding contents taken out from the tables.

For this purpose, it is very convenient to have paper of about 14 by 24 inches, ruled across in both directions, with parallel lines about $\frac{1}{10}$ of an inch apart, as in fig. 3.

Every fifth line should be stronger than the intermediate ones, if drawn or engraved; or of a different color, if ruled by a stationer. By means of the multiple ruling pens used by stationers, this paper is ruled to order, at a very trifling cost.

Fig. 3.



When this ruled paper is prepared for use at leisure moments, according to the following directions, nothing more will be required in order to obtain the data for the subsequent calculations, than a parallel ruler about 2 feet long. Those flat rulers which move on rollers are greatly preferable to those with hinges, which invariably get out of order in a short time.

The ruled paper is prepared as in fig. 3, by drawing upon some sheets, outlines of the side-slopes of an excavation, with a small piece of embankment below it; and upon others, the side-slopes of an embankment, with a small piece of excavation above it.

The heights, or depths, should be numbered along the centre line, as in fig. 3.

Finally, lay off on both sides of *o* as a centre, by means of a large protractor, single degrees up to as high as the greatest transverse ground slope for which the paper is to be used; this, as before remarked, will rarely exceed 20°; because, with high transverse ground-slopes, it is generally better to resort to retaining walls.

The paper is now ready for use, and all the subsequent operations may be performed by the parallel ruler.

One sheet may be made to serve for the calculations of many stations, by merely drawing in the transverse ground slopes, *very lightly*, with lead pencil marks, which may be rubbed out as each station is finished.

It is advisable, however, in *very irregular* sections, to represent but two consecutive ones on one sheet; and after having drawn them in ink, and added the numbers of the sections or stations to which they belong, as well as the cubic content comprised between them, to lay them aside for future reference, in case of dispute with the contractor, after the work is commenced.

The method which I advise for reducing irregular cross sections to equivalent regular ones, which may be calculated by means of the working diagrams and tables of level cuttings, is as follows:

CASE 1.—*When the ground slopes differently from the centre each way, as e d, e a, in figs.* 4 *and* 5.

Fig. 4.

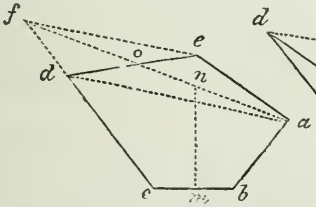
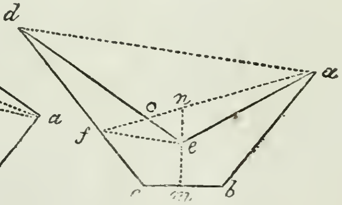


Fig. 5.



On the prepared paper, fig. 3, from the centre height or depth *e*, figs. 4 and 5, and by means of the parallel ruler, and the degrees marked on the sheet, fig. 3, draw the two slopes *e d*, *e a*, figs. 4 and 5; the inclinations of which are taken from the field slope-book. Draw *e f*, parallel to *a d*, and join *a f*. Then is *a b c f* equal to *a b c d e*,* figs. 4 and 5.

Find by means of the parallel ruler and the degrees marked on the paper, the slope of *a f*; and with that slope, and the new centre depth *m n*, (which is had from the figure by inspection,) use the proper diagram for finding the equivalent level cutting; and take out the cubic yards from the table.

Also, in fig. 5, the triangles *f e d*, and *f e a*, being on the same base *f e*, and between the same parallels *f e*, *d a*, are equal to each other; and leaving out from each the triangle *f e o*, which is common to both, we have the triangle *f o d*, *e o a*, and consequently *a b c f* = *a b c d e*.

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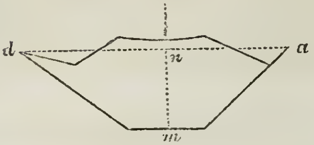
* *Proof.*—The two triangles *a d f*, *a d e*, fig. 4, being on the same base *a d*, and between the same parallels *a d* and *e f*, are equal to each other. Leaving out from each, the triangle *a d o*, which is common to both, we have the triangle *d f o*, equal to the triangle *a e o*; and consequently *a b c f* is equal to *a b c d e*.

Case 2.—*When the ground is very irregular transversely, as in fig.* 6.

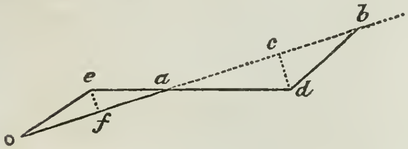
Fig. 6.



Having drawn the figure on the prepared paper, find by trial with a piece of thread, the line *a d*, which equalizes, as nearly as can be judged by eye, the irregularities above and below it. By means of the parallel ruler, and the degrees on the paper, find the slope of *a d;* and with that slope, and the new centre depth *m n*, (which is had from the figure by inspection,) use the proper diagram for finding the equivalent level cutting; and take out the cubic yards from the table.

Case 3.—*When the ground slope intersects the roadway, as in fig.* 7.

Fig. 7.



Such cases are always detected by the dotted curve line in the working drawings.

Having drawn the figure on the prepared paper, measure the two bases *a b* and *a o;* and also the two perpendiculars to them, *c d* and *e f.*

Multiply *a b* by *c d*, and half the product is the area of the triangle of excavation *a b d.* If the triangle of excavation at the other end of the 100 feet station, has the same area, the number of cubic yards corresponding to this area for a length of 100 feet will be taken from table 15.

Also multiply *a o* by *e f*, and *half* the product will be the area of the triangle of embankment *a o e.* If the triangle of embankment at the other end of the 100 feet station, has the same area, the corresponding number of cubic yards will be taken from table 15.

But if the triangles of excavation, (or those of embankment,) at the two ends, are not of the same area, the trapezoidal rule must be employed, as in the case of trapezoidal cross sections of unequal areas. See page 3.

That is, we must add together the contents of the two end triangles, and 4 times that of the triangle half way between them, and divide their sum by 6, for the true content.

The base of the centre triangle of excavation, will be the average between the two bases *a b*, fig. 7, at the ends; and its perpendicular, the average between the two perpendiculars *c d*, at the ends.

In like manner, the base and perpendicular of the centre triangle of embankment, will be averages of the two end bases *a o*, and of the two end perpendiculars *e f.*

If from irregularities in the ground, in the direction of the line of the road, it should become necessary to take cross sections nearer together than 100 feet, only the same proportional parts of the cubic yards must be taken from the tables; and on this account, it is better always, when possible, to subdivide the 100 feet station distances into such parts as will furnish numbers easy to divide by; thus, if the station be divided into 10, 20, 25, or 50 feet distances, they will furnish respectively the numbers 10, 5, 4, or 2, by which to divide the cubic yards in the tables, all of which are calculated for 100 feet distances.

To find the Distances of the Side Stakes from the Centre Stake.

In all cases in which the cross sections are drawn, as just described, these distances may be had by measurement on the figures.

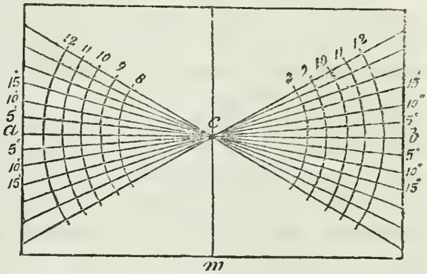
But they may be obtained much more rapidly thus: prepare a piece of tracing paper, as in fig. 8, of the same size as the ruled paper on which the cross sections are drawn.

From *c* as a centre, lay off and number the degrees, as marked at the ends, to as high as the greatest transverse ground slope in the work.

Also, from *c* as a centre, draw by the same scale as the ruled paper, fig. 3, arcs of circles one foot apart, and number them with their distances from *c* in feet.

Then, by laying this paper upon a cross section of the road, fig. 3, with *c* of fig. 8, placed at the given centre height or depth on the line *a a*, of fig. 3, we at once read off, without any calculation whatever, the distances of the side stakes from the centre stake, measured along the transverse ground slope. These distances will be copied into the proper book for field use.

Fig. 8.



If, instead of concentric arcs, vertical straight lines are drawn on the transparent paper, we shall in like manner obtain, by mere inspection, the *horizontal* distances of the side stakes from the centre one. When the horizontal distances are used in preference to those measured along the transverse ground slope, it is necessary to use a plumb at the end of the measuring line, in order to hold it vertically over the centre, or the side stake, depending upon which is lowest.

The tracing paper figure should be pasted to a frame, so as to lie flat on fig. 3. The frame may be of stiff pasteboard.

On the Usual Method of Calculating Excavations and Embankments.

Different engineers employ different methods, of which the following is, perhaps, as simple as any:

Fig. 9.

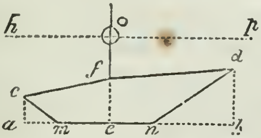
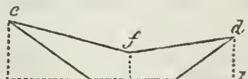


Fig. 10.



It requires that there shall be given, (beside the width of roadway *m n*, figs. 9 and 10, and the side-slope,) the extreme *horizontal* width *a b* of the cut, or embankment; and the vertical depths *f e* at the centre; and *c a*, *d b* at the sides.

The Rule then is, *multiply the extreme horizontal width* a b, *by half the centre depth* f e; also multiply ONE-FOURTH *of the width of roadway* m n, *by the sum of the two side depths* c a *and* d b: *the sum of the products will be the area of the cross section* m n d f c, *fig.* 9 *or fig.* 10.

This area, thus found, multiplied by 100, (the usual length of the station in feet,) and divided by 27, (the number of cubic feet in a cubic yard,) gives the cubic content of the station, provided the area of the cross section at the other end of the station be the same; but if not, the prismoidal Rule must be used, as already explained.

The trouble of multiplying by 100, and dividing by 27, may be avoided by the use of table 15, which I have prepared for that purpose.

The centre depths *f e*, fig. 9 and 10, are given by the level book; but the side depths *c a* and *d b*, have to be found by trial on the ground, thus: The level is placed conveniently for sighting from the same position upon *f*, *c*, and *d*.

A sight *f o*, is first taken on the target rod held at *f*; this sight *f o*, being added to the centre depth *f e*, gives the height *e o*, of the instrument above *a b;* or the horizontal plane, (represented by *h p*,) through which the line of sight passes as the telescope of the level is swept round on the axis of the instrument.

The height of *d* above *f* is then estimated by eye, say at 2 feet; this 2 feet, added to *f e*, gives the *approximate* height of *d b*. Assuming the approximate height *d b* as the correct one, we find what would be the *horizontal* distance from the centre to *d*, either by calculation, or from a previously prepared table of horizontal distances. Measure off that distance horizontally towards *d*, and placing the target 2 feet lower on the target rod, hold it at the end of the measuring distance. A sight is then taken with the level, and if it strikes the centre of the target, it proves that the assumed height of *d*, and the corresponding horizontal distance from the centre of the roadway, were correct; and that the proper spot is found for placing the side-stake *d*.

It seldom happens that such a coincidence is found at the first trial; at least two trials are generally required; and frequently three, or even four when the ground is extremely irregular.

A very close approximation, however, can always be made by an experienced leveller after the first trial. An error of an inch or two in the position of a side-stake is a matter of no practical importance whatever.

The same operation is performed at *c*, except that as *c* is *lower* than *f*, the target is *raised* on the rod, as far above the sight taken at *f* as *c* is estimated to be below *f*.

(When putting in side-stakes for an *embankment*, the sight taken on the rod at the centre stake, is *subtracted* from the centre height of the embankment, in order to obtain the depth of the instrument below the roadway.)

It is plain that if the height on the target rod at *d*, fig. 9, be subtracted from *e o*, the remainder will be *d b*; and that taken at *c*, subtracted from *e o*, will give *c a*.

These operations give us therefore, at the same time, the heights *d b*, and *c a*; and also the horizontal distances from the centre to each side stake. All these are at once entered into the proper field-book, to be used in estimating the areas and cubic contents in the office.

The sum of the two horizontal distances manifestly gives the extreme width of the excavation or embankment.

It is evident, that in the time required for a leveller and rodman to ascertain the positions and heights of the side-stakes, at a single station, by this method, those of several stations could be found by one person in the office, by mine.

Still, in some rare cases, where the ground-slope is extremely irregular, as among jagged rocks, the mode by the level is the only one proper to be used; as, in that case it would be impossible to take the transverse ground-slopes with any degree of accuracy.

Transverse ground-slopes are obtained in the field with great facility, by means of a small slope level, or *clinometer*, placed upon a rod, 10 or 12 feet long, which, at every station, is laid upon the ground as near at right angles to the line of survey, as can be judged by eye. These clinometers are sold by most of our principal instrument makers.

When the ground is regular transversely, but one slope need be taken; at other times, one may be required from the centre each way; and rarely, more than one on each side of the centre-stake. The slopes for estimating the final adopted line, must be taken with much more care than during preliminary surveys of trial lines. They need not, however, extend beyond the widths actually occupied by the cuttings and fillings; while those taken in preliminary surveys, should comprise a considerable width, as they are, moreover, used in the office for changing the position of the surveyed line, in order to avoid excavation and embankment.

To be Continued.

For the Journal of the Franklin Institute.

On the Comparative Qualities of the Metal Employed in the Construction of Railroads. By Hu. L. Damsel.

Now that the demand for railroads has become so extensive, though limited to such as promise to be directly profitable to their proprietors or beneficial to the community at large, the comparative qualities of the metal employed in their construction, deserves to be more closely investigated than has hitherto been done. The subject is one which has not received that attention and examination from scientific men, which its direct connexion with the successful working of railroads demand. Large sums are annually paid for rail-bars which may or may not be applicable to the purposes for which they are intended. They may last many years under a heavy traffic, or their duration may not exceed a few months of comparatively light traffic. The probabilities are as much in favor of one as the other.

On the introduction of railroads, engineers were of opinion that iron railway bars would endure for an indefinite period, and that their destruction would eventually be effected by the oxydation of the metal from its exposure to atmospherical changes. But a real iron way had not long been constructed and in use, before it was discovered that the iron bars were subject to abrasion and disintegration, by the sliding and rolling of the locomotive engines and carriages that traversed it, and that on lines having a considerable traffic worked at high speeds, their destruction was effected within a very limited period. The injury to the rails from oxydation of the surface is scarcely perceptible on those constantly in use. The abrasion of the head of the rail, thereby diminishing the width and depth of the bars, is on some railroads, under certain conditions, the means of lessening the duration of the rails. But lamination, or a disintegration of the fibres of the metal composing the wearing part of the rail, is a fruitful source of expense on numerous railroads in Europe and America.

No sooner, however, was it discovered that the bars were liable to laminate and splinter, than a number of inventions were produced with the view of obviating the evil, and their projectors, impressed with the idea that the shape of the rails was faulty, promulgated the most ridiculous designs that can be imagined. Flat bars were proposed as the least liable to laminate, and these, if unattended with other objections, would probably be the cheapest of any. Indeed, where bar iron is expensive, timber cheap, and the traffic light, the flat plate rail is perhaps the most economical that can be adopted. Square bars, it was supposed, could be laid on their different sides in succession as each became worn, until reduced to the size of a nail rod. Round rods were gravely recommended as still superior, for they, it was imagined, could be turned around a fraction of a circle, so as to offer a fresh bearing surface, whenever it was required: the operation being repeated until the rod was reduced to a mere skeleton of its former self. Parallel rails with head and foot alike were proposed, and in many instances adopted, from the mistaken idea, that when one side was worn they could be reset in an inverted position, and thus be as good as new—forgetting altogether that the inverted rail would not fit the others in height, nor the chairs in section. But, lest the upper and under sides of the parallel rail should not afford sufficient wearing surface, rails with three and others with four heads have been invented and patented.

Meanwhile, railroad companies have adopted almost every variety of section. Parallel, T or web-footed, bridge, and plate rails have been used with more or less success. From the diversity of opinion which exists among engineers respecting the best section for iron rails, it may justly be inferred, that of itself it is a matter of very little importance. In England the bridge, and parallel rails, and in the United States the plate, and web-footed rails, are the prevailing sections; while on the Continent of Europe, bridge, parallel, web-footed, and plate rails are used indiscriminately on the same line of road. This diversity of opinion among engineers respecting the best section for a rail bar descends also to their proportions, for while one engineer constructs web-footed rails of a given weight per yard, 3 inches high and 1½ inches thick, another fashions the same weight of metal into a rail 8 inches high, and but ½ inch thick in the centre. The bridge rails originally on the Great Western Railway, in England, were but 1¼ inches high; those laid on some Irish railways were 4 inches high.

The occurrence of lamination in the rails may be traced to one or more of the following causes: 1st, From the line of rails being unsupported with a sufficiency of suitable sleepers and ballasting. 2d, From the improper state of the working stock. 3d, From a disproportion between the quantity of metal in the bars, and the weight of the locomotive engines and rolling load, and the velocity at which these are propelled. 4th, From the imperfect and negligent manner in which the bars are too often manufactured. 5th, From their having been manufactured from improper metal.

The condition of the permanent way has an important connexion with the duration of the rails. If the ballasting has originally been made of unsuitable materials, or if it has since been negligently maintained, the very best rails are as liable to injury from this cause as the very worst. It matters not what care may have been taken in their manufacture, if the rails are not properly supported at necessary intervals, or, what is better, continuously, crushing and lamination will ensue. With rails supported on transverse sleepers at fixed bearings, the slackness of a sleeper will be sufficient to laminate a rail, which otherwise would have remained sound for years. And too great a distance between the bearings, in proportion to the depth of the rail, and weight of the loaded wagons, is attended with similar consequences.

Laying the rails on longitudinal strings of timber is certainly the best mode of fixing them, and one that ought to be more generally adopted. To be really effective, however, the pieces should be of larger scantlings than those hitherto used, and maintained carefully packed up by the ballasting. By using larger timber, the injury to the rails from the deflexion of the stringers would be reduced to very narrow limits.

The state of the rails on bridges formed of wood or metal, offers instructive examples of the injury which may result to the rail bars by their deflecting considerably from a right line.

Injury may also be occasioned to the rails by the use of badly constructed carriages, wagons, and other working stock. Carriages and wagons without bearing or other springs, are more injurious than those fitted with such springs, though not to the extent generally supposed. The beneficial application of such springs is limited to passenger and other carriages running at high velocities. For the conveyance of minerals, heavy goods, and lumber, generally at low speeds, wagons without springs are used in many localities with decided economy. The distance between the axles of the wheels and the height of the wagons affects the wear on the rails, as also does the materials of which the wheels and tyres are made, but to an inconsiderable extent compared with others.

As frequently being the direct cause of shearing and splitting of the rails, the condition of the wheel tyres belonging to the working and rolling stock, requires notice. When tyres of the usual width and gauge are much worn, a groove is sunk in the wearing part, and a shallow flanch, as it were, is formed on the outside of the tyre. In the ordinary course of working, this artificial shallow flanch will at times roll on the rail, and as the bearing surface which it presents is but a mere fraction, and that at the extreme outside of the rail, a place frequently made of diminished section, an immediate or ultimate severance of a narrow strip of the rail is the almost certain consequence whenever this occurs. When the wheel tyres are permitted to wear into grooves, whether from negligence or ideas of economy, the broken and splintered state of the outside edge of the rails is most evident. If permitted to do so, this ragging and splintering of the rail bars will extend inwards, and ultimately occasion their renewal. But if, on the appearance of a groove in the tyre, the wheels are at once removed from use, and the tyres turned in a lathe to restore them to their original contour, the instances of lamination on the outer side of the rails, now so frequently observed, would be greatly lessened.

On the first railroads the rails were much too slight, even for the light engines and loads and moderate velocities which their promoters then contemplated as sufficient. The subject was in its infancy, and the weights and sections then adopted were considered the best and most economical in the opinion of the engineers of that period, who had not then obtained that experience respecting the properties of wrought iron to resist wear and tear, under circumstances similar to those under which they were required to act, which they have since acquired. It is, therefore, not surprising, that when the weights of the locomotive engines and loads, and the velocities at which they traveled, were doubled and even trebled, the rails shewed unmistakeable symptoms of being too slight, and otherwise unfitted for the heavier work passing over them.

Railroad directors and engineers are now convinced that for railroads of the usual description, rails weighing from 60 to 90 pounds per lineal yard, are more economical than those of a less weight.

With respect to the employment of unsuitable metal in the manufacture, it must be admitted by every impartial observer, that rails are for the sake of cheap production, too often made of unsuitable materials, for which, however, while railroad companies, actuated by motives of economy, refuse to pay proper prices, the manufacturers are not alone to blame. And yet it is well known to railroad engineers, that the metal employed has a most important bearing on the durability of the rail. And notwithstanding their endeavors to buy cheaply, railroad companies are unremitting in their exertions to secure good rails. It is with this object in view, that the specifications furnished by them to the rail manufacturer, are so plentifully supplied with directions for his guidance and instruction, in manufacturing this great desideratum. But in their ignorance of the changes which iron undergoes in the different processes of its manufacture, and in their anxiety to secure durable rails at low prices, they have stipulated that a certain portion of the metal used in manufacturing each bar shall be of a defined quality—superior to the rest—and have overlooked the fact, that this metal may be of a high quality, yet unfitted for the particular purpose for which it is intended, may have been manufactured with great care, and yet in practice be injurious to the durability of the rail.

To explain this inconsistancy, it is necessary to state, that iron rails of whatever section, are rolled from a number of short flat bars, placed one on the other to form a "pile," as it is technically called, of the requisite size and weight. This pile for rails of ordinary dimensions is about 3 feet long, 7 inches wide, and 9 inches high. With the present system of manufacturing, the body of the pile is built up with puddled iron, averaging about 3½ inches by ½ inch thick, and the length of the pile, while the top and bottom are each composed of an iron plate about 1 inch thick by 7 inches wide, and of a similar length with the others.

These plates are dignified with the appellation of "best iron." Their employment is usually specified in all contracts, and is therefore compulsory on the part of the manufacturer. When rolled, the metal in these plates forms portions of the head and foot of the finished rail.

By this compulsory use of best iron, railroad companies imagine that the superior qualities of the rails so manufactured are increased, and that they are consequently better calculated to withstand the wear and tear resulting from the rolling of heavy bodies at high velocities; but the very opposite is the case. Instead of increasing the resisting properties of the rail, it diminishes them, and is directly or indirectly the cause of nine-tenths of the lamination which occurs on the railroads of Europe and America.

Extraordinary as this may seem, it is no less true, that the use of this best metal has a most prejudicial effect on the duration of rails, under whatever circumstances they may be situated. On the occurrence of lamination, it will be found that the strip of metal severed from the body of the rail rarely exceeds one-third of an inch in thickness, let its breadth be what it may. By referring to the materials of which the rail is rolled, it will be observed that the plate of best iron, 1 inch thick, 7 inches wide, and 3 feet long, is, in the process of rolling, extended over the head of a rail, probably 20 or 24 feet long, and 3 inches wide, thus becoming reduced to less that one-third of an inch in thickness. It is this thin covering of best metal which it is customary to place on the heads of the rails to resist the wear and tear from the rolling of millions of tons of traffic. If soundly welded to the other layers, such a thin provision for wear may bear a few millions of tons; but if otherwise, it will probably peel off in long thin flakes before it has borne many thousands. Unfortunately for railroad companies, this last is too frequently the case.

The perfect union of the top plate to the puddled bars composing the body of the pile, is seldom accomplished. For, besides the risk which is necessarily incurred, where the welding of two plates of the same metal, but in different stages of manufacture, is involved, the top plate, from its superior dimensions and capacity for caloric, requires a proportionably longer period for elevating its temperature to the welding point. The sectional area of the top plate is 7 square inches, that of the puddled iron bars $1\frac{3}{4}$ inches, or just one-fourth of the other. Now, the time required for heating masses of metal to the same temperature throughout, when they are similarly situated, is nearly in proportion to their magnitudes; consequently, the intense heat of the balling furnace, if continued sufficiently long for thoroughly heating the large plate, must necessarily burn the small bars, but if proportioned to the capacity of these, the outside only of the large plate can be brought to the welding temperature. Hence, if soundness is obtained in the wearing surface, it is by the weakening in an equal ratio of the other portions of the bar.

In practice, however, the head and bearing surface is rarely sound. The desire of producing large quantities of rails in a limited period, induces the manufacturer to hasten the heating process, and thus, the pile is not unfrequently drawn before the smallest bars have been properly heated. By so doing, the waste of metal and consumption of fuel in the operation, is considerably diminished, and a corresponding saving effected to the manufacturer.

The workmen, too, from being paid by contract on the quantity produced, have a direct inducement to withdraw their charges before they have been properly heated, of which it is believed they take advantage, to the loss of the purchaser.

But if exposed to the heating process for a length of time sufficient to elevate its temperature to the welding point, unless it receives that attention from the workmen which the delicacy of the operation requires, the welding of the different plates will be more or less imperfect. From the interior construction of the reverberatory furnace, extreme watchfulness is required from the attendant. The fire place being situated at the end, the flame and heated products of combustion pass over and against the piles reposing on the sand bottom of the furnace. The piles, if permitted to continue in the same position, will be quickly heated on the top and side next to the fire, while the bottom and side farthest from it will remain comparatively cool. It is the especial duty of the workman, to guard against the overheating of any part of the pile at the expense of the other portions, by exposing the different sides in succession to the fire, so that each may be brought to the desired temperature. This, by the employment of careful workmen, and a close supervision on the part of the manufacturer, is usually accomplished; but cases do occur, where one side only of the mass has been sufficiently heated, and as a necessary result, the rail manufactured from it is sound on one side, but imperfect on the other.

In support of the assertion, that the layer of best iron is seldom welded to the other portions of the rail, it may be stated, that with the view of ascertaining the proportion of rails in which it is usually accomplished, a series of experiments were made on various rails, manufactured in the usual manner, and in all respects equal to the rails now manufacturing for the European and American railroad companies.

Nearly 50 tons of rails were experimented on, at an expense exceeding $2000. The results, as will presently be seen, afford the most conclusive evidence, that the employment of best iron in the manufacture, as it is at present conducted, is attended with positive injury to the durable qualities of the rail.

The plan adopted to test the soundness of the rails, was to fix one or two iron blocks placed about two feet apart, and apply pressure to the upper side, until the bar took a permanent set of from $\frac{1}{4}$ to $\frac{1}{2}$ inch from a right line, when it was refixed in an inverted position, and the pressure applied until it took a similar set in an opposite direction. The operation was repeated four or five times, when the bar, from the violent strain to which it had been subjected, generally broke at nearly right angles with its plane. It was anticipated that before the fracture would be completed, the plates which had not been perfectly welded, would separate in distinct layers, in consequence of the violent depression acting alternately on either side of the rail, and in practice this was found to be the case.

The first lot of rails tested in this manner, consisted of 50 bars of the T, or web-footed section, weighing about 62 lbs. per yard, and manufactured in the manner previously described, viz: a number of small bars of puddled iron capped by a large plate of best metal, and having a quantity of similar metal in the foot. They were the surplus rails of a large contract, and were of a fair average quality. When broken, of these fifty bars, *seven* exhibited every appearance of a complete union of the metal in the top plate with that in the small bars; in 27 the union was more or less perfect; but in the remaining 16, it was limited to the surface, and on applying the test to these, the head of the rail to a depth of full quarter of an inch, the wearing part about which railroad companies are so solicitous, was completely severed from the rest of the rail.

These results, showing as they do, that so large a proportion as seven-eighths of the rails manufactured under the present system are imperfect and extremely liable to laminate, were so extraordinary, that the experiments were repeated on a fresh lot of rails of the same pattern, selected indiscriminately from a heap of several hundred tons, which had been manufactured at a period anterior to that of the previous lot.

One hundred bars were experimented on in the manner previously described, and with results equally unfavorable to the durability of the rail; of the 100 tested, 13 were considered complete and free from any imperfection in the welding; 59 were partially united, generally on one side only, as if the other side had not been properly heated; while 28 were scarcely at all united.

For the purpose of ascertaining if this large proportion of defective rails, held good, also with differently shaped bars, 60 rails of the bridge pattern, weighing 70 lbs. per yard, were tested in a similar manner, and with like results. Twelve were found quite sound, 33 were more or less defective, and in 15 the union of the metals was merely superficial.

That the defective state of the manufacture is not of recent date, may be inferred from the results which were obtained by testing rails of various sections, manufactured at a period coeval with the introduction of the railway system itself. Sixty-two bars were experimented on, when it was observed that 13 were efficiently welded, 29 partially so, and 20 were defective, inasmuch, that the union of the metals was confined to the surface of the rail, and rarely extended inwards more than an eighth of an inch.

Thus, of 272 bars tested, 45, or 17 per cent., were sound and free from any defects in the welding of the top to the other plates; 148, or 54 per cent., were more or less imperfect; while in 79, equal to 29 per cent. of the whole, the top plates were but superficially united to the others.

The perfectly sound bars would probably wear for some years, the imperfect ones might, under favorable circumstances, stand considerable rolling before laminating, but the remaining quantity, which had not been welded, would not sustain any heavy traffic. It is, therefore, not surprising, that with such a large per centage of imperfect rails, lamination should extensively prevail on the majority of railroads now in use.

Objections may be urged against the mode of testing the rails, as being unlike anything occurring on railroads; and certainly, when it is considered that the bars were violently deflected until they were fractured, the objection appears to be a just one. But it is submitted, that although the test was excessive for the time which it occupied—a few hours—yet the repeated deflexions of the rails by the passage of heavily laden trains, going at high velocities, must necessarily have a similar tendency to loosen the plates composing the rail, when it is imperfectly manufactured.

The different capacity for caloric, possessed by the different bars composing the rail pile, has been completely overlooked by railroad companies and engineers, though perfectly well known to every common blacksmith. He is well aware, that the time necessary for thoroughly heating a piece of metal, is in proportion to its magnitude, and when welding two pieces of metal of unequal dimensions, is careful to insert the largest piece first, that it may receive an accession of temperature corresponding with its dimensions before commencing with the other piece. But in manufacturing railroad bars, the case is different. Bars of iron weighing 70 lbs. and others weighing but 18 lbs. are inserted and withdrawn from the heating furnace together, although the former requires four times the quantity of caloric which is necessary for the latter. The precaution adopted by smiths, of inserting the largest piece first, is in the case of rails precluded from the altered conditions of the manufacture. In the ordinary smith's forge, the operations are limited to the forging and joining together of two pieces of wrought metal, and the extent of these, which is acted on at each heat, is short, seldom exceeding a few inches. But in manufacturing rail bars, the number of pieces to be heated and united into one compact mass at a single operation, frequently exceed twenty, a number which it would be impossible to pile one on the other with the requisite rapidity, if heated singly, to render the subsequent process of rolling complete. Before twenty separate pieces of metal could be withdrawn from a furnace, and properly arranged to form the pile, their temperature would have been reduced below the welding point, and their subsequent union by pressure under the heavy rolls, could not be effected.

The employment of the best iron in the rail pile, is attended with another disadvantage. It is generally admitted, that the metal in the wearing part of the rail should be hard and crystalline in its texture, and premising that the thin veneer of best iron has been securely united, it fulfils neither of these conditions. It is remarkable for its softness and fibrous character, manufactured from the same description of puddled iron as that employed in the body of the pile, the difference between them consists in its having visited the heating furnace, and passed between the rolls to be converted into best iron. By this extra rolling, it has increased its fibrous character, and parted with a portion of its cinder, to which it owes its welding properties. On being reheated in conjunction with the raw puddled iron, it is incapable of furnishing the quota of cinder necessary to their complete cohesion, and the weld, though apparently perfect, is incomplete, while the metal itself, from repeated rollings and reheatings, has become of an open, fibrous character, easily ruptured by pressure and concussion.

It is not easy to exaggerate the injurious effects which result to the texture of the metal from a repetition of the heating and rolling process. The fibrous character of the metal partially developed in its passage between the puddling rolls, becomes strongly marked on reheating and rolling it a second time, and highly fibrous on heating and rolling a third time. Twenty to twenty-four bars of puddled iron laid one on the other, produce when heated and rolled, the common merchant bar iron of commerce, and this bar iron, when cut into suitable lengths, piled, heated, and rolled, produces the quality known as "best iron." Now, it is very evident, that if there be a certain number of fibres in a bar of puddled iron, the merchant bar produced from twenty or twenty-four of these bars, will contain twenty or twenty-four times the quantity of fibre, and it is equally evident, that the best iron rolled from twenty or twenty-four of these merchant bars, must contain from four hundred to five hundred and seventy-six times the number of fibres that existed in the original bar of puddled iron.

If fibre was desired in the rail bar, a repetition of the heating and rolling processes, would meet the desired results, but with an earnest desire for a non-fibrous rail, it is surprising how railroad companies should adhere to the employment of the best iron in the wearing part of the bar.

The obvious remedy for these imperfections, is a total and immediate abandonment of the objectional plate of best metal, and the substitution of its weight of puddled iron of the usual dimensions. The pile would then be built up with bars of one uniform size, and when exposed to the heat of the reverberatory furnace, each bar would receive a similar accession of temperature up to the welding point, when the whole of them could be permanently united into a solid bloom.

The puddled iron being comparatively free from fibre, is particularly adapted for the wearing part of the rail; and being obtained at a lower price than the best metal now used, the cost of manufacturing the rail would be considerably reduced, and the price to the purchasers would eventually experience similar reductions, in consequence of the strong competition which exists among mill owners.

But should there be a desire to retain the best iron in the wearing part, a number of plates of a similar size with the puddled bars, should be used instead of the large plate now employed. A perfect weld might then be obtained with the care and attention ordinarily bestowed on the operations of the heating furnace. But it is believed, that such rails will still be liable to laminate from the fibrous character of the metal, and that rails made without any admixture of such highly wrought metal, will be found most advantageous for railroad purposes.

AMERICAN PATENTS.

List of American Patents which issued from May 20, to June 10, 1851, (inclusive,) with Exemplifications by Charles M. Keller, *late Chief Examiner of Patents in the U. S. Patent Office.*

24. For an *Improvement in Scarificators;* Frederick Leypoldt, Philadelphia, Pennsylvania, May 20.

Claim.—"What I claim as my invention, is the use of the said hollow pivot lever, and slide racks, combined and arranged as described, secured in their proper places by the plate and screws, and operating in connexion with the trigger and springs, substantially as herein before specified."

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25. For an *Improved Compound Coupling for Hose or Pipe;* James W. Osgood, Columbus, Ohio, May 20.

Claim.—"What I claim as my invention, is the manner, if desired, of keeping the several threads or screws always in contact, whether the coupling be formed or disconnected, for obtaining the advantages set forth by the employment of an interior box situate in an outer box, and having a loose ring or collar (or its equivalent,) on it, in combination with a washer, connecting nut, and box, formed with lips for locking the coupling; the several parts constructed, fitting, and operating together, substantially as shown and described."

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26. For an *Improvement in Smut Machines;* Nelson Pratt, Ottawa, Illinois, May 20.

Claim.—"What I claim as my invention, is, 1st, In connexion with a close case surrounding the machine, the arrangement of the fan, as herein described, in the annular space surrounding the beaters between the outer case and the fluted cylinder, and at the entrance of the pipe, through which the dust is discharged, so that currents of air will set into the machine through any cracks or openings in the same, from the room in which it is placed, by which means, the escape of pulverized dust or smut into the room is effectually prevented.

"2nd, I claim the arrangement of the air chamber, having currents of air passing through and across it, between the upper part of the beater and the space through which the descending current of air passes to the fan, for the purpose of collecting any portion of the grain accidentally thrown out of the scouring cylinder, by the blast or beaters, and returning the same, so that it may pass through the machine with the rest of the grain, in the proper direction.

"3d, I claim the conical ring or shield, for the purpose of protecting the conical screw below it, from abrasion by the descending grain. and at the same time, keeping the pores of the screw open, for a free passage of air through it into the fluted cylinder.

"4th, I claim the tube or passage for discharging the cleaned grain as set forth, and also for receiving and transmitting air to and through the tube, as described."

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27. For an *Improvement in Planing Machines;* George W. Beardslee, Buffalo, New York, May 20.

Claim.—"Having thus fully described my invention, what I claim therein as new, is the yielding stock and cutter, when made to yield upon an axle, the centre of which is in line with the cutting edge of the knife; and this I claim, whether the socket bolt, hinged bar and nut, are or are not used for the purpose of graduating and adjusting the cutters, as herein set forth."

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28. For a *Coupling for Cords;* Lawton J. Ware, Warren, Rhode Island, May 20.

Claim.—"What I claim as my invention, is the use of half coupling, (each of similar shape and construction,) formed with lips having slots, into which projecting hooks fit, having notches serving for the bolts to enter and lock the coupling; or constructed and operating for the purposes shewn, in any manner substantially the same."

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29. For an *Improvement in India Rubber Shoes;* Horace H. Day, Jersey City, New Jersey, May 20.

"The nature of my invention is the peculiar arrangement and combination of known materials to be used in the manufacture of shoes, suitable for men, women, and children, principally as overshoes; by which means I produce shoes having new and useful qualities never before obtained, and at a less cost than any known before my invention."

Claim.—"Having described the advantages of my improvement, and the best way known to me of manufacturing the same, what I claim as my invention, is the manufacture of rubber boots and shoes without cloth, being made of separate pieces of different degrees of elasticity, and each piece having its peculiar and requisite degree. The shoe, to possess different degrees of elasticity in different parts, and uniform elasticity in each different part, and having no part without some elasticity in every direction, by the means herein described, or any other substantially the same, whereby I lessen the cost, obtain a shoe not liable to break, which can be kept clean, stretched in every direction at the same time; easier to the foot; adjustable to larger boots, and yet not rendered useless to wear over smaller; light and elegant, and retain permanently their shape."

30. For *Improvements in Reflecting Fire Places;* Robert Jobson, near Dudley, England, May 20; ante-dated December 28,1848.

Claim.—"I do not claim as my invention, a reflector made to partially surround the fire, but what I claim as my improvement, is the extension of the curved reflector entirely around the fire grate, in combination with having an opening through it, immediately under the fire grate, for the passage of the ashes, as specified.

"And in combination with the fire grate and the extension of the reflector under or below the grate, essentially as explained, I claim the ash guard, the same being applied in manner and for the purpose as set forth. And in combination with the reflector, and its sustaining frame, I claim the hinged slide, and the sustaining rollers, or their mechanical equivalent, the same being applied so as to enable the reflector to be moved outwards for the purpose of providing easy access to the chimney, for convenience of removing the ashes, whenever such may be deemed necessary."

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31. For an *Improvement in the Manufacture of Wire Strengthened Spoons, etc.;* Luther Boardman, East Haddam, Connecticut, May 20.

Claim.—"I do not claim employing a wire within the handle, as such has already been done; but what I do claim as my invention, is the manner substantially as herein shown and specified, of enclosing a wire of the required exact length within the handle, by supporting it on "points" secured to the moulds, and projecting midway or partly into the form."

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32. For an *Improvement in Steam Traps;* Charles M. Guild & John Brown, City of New York, May 20.

Claim.—"We do not claim to be the first to remove the water of condensation from steam warming or other apparatus, by means of a float and valve, or cock, but we do not know of any means by which this water of condensation is taken off through the float by a cock; therefore, what we claim as new and of our invention, is the construction and application of the float, with its mouth, opening, pipe, and barrel, on the plug, with the openings, and for the purpose of retaining the steam in warming apparatuses or in other steam pipes, and passing out the water of condensation through the float, near the bottom, substantially as described and shown."

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33. For an *Improvement in Hot Air Furnaces;* Samuel Pierce, Troy, New York, May 20.

Claim.—"What I claim as my invention, is the arrangement substantially as herein described, of the heating chambers in connexion with the furnace, when this is combined with the method substantially as described, of connecting the heating chambers with each other, with the furnace, and with the exit pipe leading to the chimney; whereby, the gaseous products of combustion are carried into and through, and made to spread out in their films in the said heating chambers, and therein retained to give out heat, without seriously impeding the draught, substantially as described."

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34. For an *Improvement in Carriage Springs;* Levi Bissell, City of New York, May 20.

Claim.—"What I claim as new, is the construction of springs, whether of wood, or part wood and part metal, or other elastic or non-elastic substances, as adapted and applicable to carriage springs, and springs for other purposes, in the manner substantially as herein described."

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35. For an *Improvement in Cast Iron Car Wheels;* Albert Hebbard, Worcester, Massachussets, May 20.

"My improved wheel has a combination of the single plate and double plates, between the hub and the rim. Besides, it has the advantage of not only a solid, but what is usually termed an undivided hub."

Claim.—"What I claim as my invention, is the above described improvement, or wheel, made with a chilled rim, either a solid hub, or one divided crosswise of its axis, two plates or discs, united in a serpentine curve at their outer peripheries, a third plate, not only made serpentine, concentrically, with the hub, but curved in radial directions, as described, all cast or founded and combined together in one piece, substantially in the manner as herein before specified."

36. For an *Improved Gauging and Heading Movement for Spike Machines;* Purnel Jefferson, Bridgeton, New Jersey, May 20.

Claim.—"What I claim as my invention, is the combination of the spring gauge and catch, constructed as herein described, with the dies, and with the header for the double purpose of gauging the length of the spikes or nails, and aiding in forming the heads thereon, substantially as herein set forth."

37. For an *Improvement in Cast Iron Car Wheels;* Isaac Van Kuran, Boston, Massachussetts, May 20.

"The nature and object of my invention is, the construction of a cast iron car wheel, which will combine strength of form with great lightness of materials, and for this purpose I cast the wheel with a solid hub, and join the said hub to the tread, by a curved plate next to the hub, which plate is strengthened by curved outside braces, then a circular tube running round the face of the wheel, and then a curved plate joined to the said tube and the tread of the wheel.

"The outside curved plate is also strengthened with outside braces, running in such a manner, that the curved braces on the inside curved plate next the hub, branch out so as to be opposite to the spaces between the outside braces."

Claim.—"Having thus explained my invention, I claim a cast iron rail road wheel, constructed with the solid hub, and the tube, the said tube being united to the hub, by a curved plate with curved projecting braces on it and connected to the tread by a curved plate with the curved braces on it; the whole being constructed, substantially as described for the purpose set forth."

38. For an *Improvement in Ventilating Furnaces;* Henry Ruttan, Coburg, Canada West, May 20: Ante-dated, Jan. 31.

Claim.—"What I claim as my invention, is the arrangement and mode of operating the valves, in reference to the air heating space around the stove, by which the amount of air from within and without is graduated by a single movement.

"I claim, also, the arrangement of the horizontal air heating trunk, the vertical leading thereto, and its valve in combination with the air heating space."

39. For an *Improvement in Grain Harvesters and Binders;* William Watson, Chicago, Illinois, and E. Sabine Renwick, and P. Hill Watson, Washington, District of Columbia, May 20.

Claim.—"Having thus specified our improvements in harvesting machines, what we claim as our invention, is, 1st, the method of raking and binding grain at one operation, by the mechanism herein specified, or its equivalent, substantially as herein set forth.

"2nd, We claim the arms in combination with the levers by means of which the rake teeth are alternately raised and depressed, as the rake is moved alternately in opposite directions, by endless rake chains, which move continually in the same direction.

3d, We claim the method of adapting the binding apparatus to the length of the cut grain, by varying the respective positions of the cutting and binding apparatus, substantially as herein set forth, that is to say, by moving the front of the platform with the cutting apparatus, backward or forward, or by moving the binding apparatus nearer to or farther from the front of the platform, in such manner that the sheaf may be bound near the middle of its length, whether it be long or short.

"4th, The method of binding grain by the mechanical devices herein specified, or their equivalents, acting in connexion and automatically by motion, derived from, or dependent upon, the movement of the machine to which they are attached.

"5th, We claim the cord finger operating substantially as herein set forth, by the aid of which the grain is encircled by the binding cord.

"6th, We claim the tying forceps, or the equivalent thereof, operating in connexion with mechanism, for encircling the grain with cord or band, substantially as herein set forth."

40. For an *Improvement in Lifting Jacks;* Boliver Newbury, Catskill, New York, May 27.

"The nature of my invention consists in an improved combination of ratchels, pawls, and springs, with a lever to which a pumping or vibrating motion is given, for the purpose of throwing out or drawing in the lifting rod from or to the post, or standard of the jack."

Claim.—"What I claim as new, is the combination in the manner substantially as herein described of the pawls *f f*, the springs *o* and *i i*, and the spring lever *k*, having projections, 1 2, on each side of its fulcrum, with the lever, D, and the ratchets, *a b*, on the lifting rod, B, whereby the lifting rod may be forced out from, or drawn in to the post, or standard of the jack, according to the position of the spring lever."

41. For an *Improvement in Lap Anvils for Shoemakers;* Henry Brunk, Albany, New York, May 27.

Claim.—"What I claim as my invention, is a metal anvil, shaped substantially as set forth and described in the within specification, with its drawings; that is, with a form adapting it to be held conveniently upon and between the knees and thighs of a workman, having a projection above the mass of metal conveniently formed into an anvil face, with a small prismatic block near the extremity of one of the arms, as a fulcrum for nippers, when the same are used in stretching or manipulating leather."

42. For an *Improved Combination of Dies for Sheet Lead Machines;* John Robertson, Brooklyn, New York, May 27.

Claim.—"What I claim as my invention, is the adjustable interior cylindrical, and the exterior stationary conical dies, in combination and for the purposes described, irrespective of the precise manner in which they are applied, or by which the adjustment is effected."

43. For an *Improved Vice Jaw for Saw-Filing Machinery;* George W. Putnam, Moreau, New York, May 27.

Claim.—"What I claim as my invention, is the jaws of the vice shaped to correspond to the shape of the saw teeth, and support the same, so as to prevent vibration during the operation of filing, as herein set forth, whereby a better edge is given to the tooth, the wear of the file is diminished, and the process of sharpening expedited."

44. For an *Improvement in Alloys of Iron, Zinc, and Nickel;* Otis Boyden, Newark, New Jersey, May 27.

"The nature of my invention consists in the manufacture of wrought or malleable cast iron, either directly from the ores or from ordinary cast iron, and the application of the following chemical agents, namely, 1st, Metallic zinc, either pure or the ordinary spelter of commerce. 2d, An alloy of zinc and nickel. The application of these chemical agents consists in mixing them, that is, the zinc alone, or combined with nickel in any manner, and in proper quantities with the crude iron, or with iron, or with iron ores while in a fused state during the process of ordinary manufacture, or of any mode of manufacturing or purifying iron whatever."

Claim.—"What I claim as my invention, is the making of wrought or malleable iron either from ordinary iron, or from the ore, by the use or application of metallic zinc or spelter, and by the use of zinc and nickel combined, as hereinbefore described and set forth."

45. For *Improvements in Machinery for Hardening and Straightening Saws, &c.;* Henry Waterman, Williamsburg, New York, May 27.

"When saw plates are hardened in the usual way, they come out warped and irregular, and with a want of equal density, the steel wanting that compactness so valuable in cutting tools, and which is never effected when the plates come from the roller. To straighten the saw plates, and at the same time to regularly condense and harden them, is the object of my invention."

Claim.—"Having thus fully described my improvements in the method of straightening and hardening saws, &c., what I claim therein as new, is the employment of the apparatus above set forth, for straightening and hardening steel plates, for saws &c., at one operation, consisting of the fingers or cams substantially as described, which support the article to be straightened, compressed, and hardened, combined with, and griped by the drop, in the manner and for the purpose above specified."

46. For an *Improvement in Seed Planters;* Jacob Barnhill, Circleville, Ohio, May 27.

"The nature of my invention consists in the mode by which the seed are made to issue from the lower box and are discharged. This is accomplished by means of a series of four or more conical cups attached to segmental rods working through leather in the bottom of the box, and extending from levers upon a horizontal shaft under the seed box; these cups are made of any capacity, corresponding with the quantity or kind of seed to be sown, and are alternately raised and lowered in the inside of the lower box, by means of levers operated upon by eccentrics and rods, hereafter more fully described."

Claim.—"Having thus fully described the nature, construction, and operation of my seed drill, what I claim therein as new, is the conical cups attached to segmental rods, extending from levers working on a horizontal shaft raised and lowered by the eccentrics and rods subtantially as described, operating in the manner and for the purpose herein fully set forth and represented."

47. For an *Improvement in Portable Swings;* Enoch S. Parson, Philadelphia, Pennsylvania, May 27.

Claim.—"Having thus fully described the construction and operation of my improvement in portable swings, what I claim therein as new, is the suspension of a swing to the hinged frame, supported or strengthened by the adjustable brace C, substantially as herein set forth."

48. For an *Improvement in Carriages;* George B. Durkee, Alden, New York, May 27.

"The nature of my invention consists in forming the sides of the box of the carriage of a series of springs of wood or other material, confining the ends of the said springs or rods at the corners of the box, and also attaching themto each other, in the centre of the said sides, the springs being generally, (but not necessarily,) placed one above the other, producing, when the carriage is sprung by persons upon the seat, a curved tray shaped box, (the curve downward,) which shall comprise cheapness, lightness, and elasticity, with beauty and strength."

Claim.—"What I claim as my invention, is, making the sides of the bodies or boxes of carriages of a series of springs, slats, or bars, when the same are constructed and operate substantially as herein set forth and described."

49. For an *Improvement in Omnibus Steps;* W. H. Hoyt, New York City, May 27.

"The nature of my invention consists in having a rear portion of the body of an omnibus project downwards sufficiently to form a step, said step being covered by the door when closed; by this arrangement the accidents daily occurring in consequence of persons standing upon the steps of omnibuses as at present constructed, are entirely prevented."

Claim.—"What I claim as new is, the manner of constructing the step as described, viz: by having a portion of the body of the omnibus projecting downwards a suitable distance, the bottom of said projection forming the step and so arranged as to be perfectly covered and protected by the door when closed, substantially as described."

50. For an *Improvement in Carriages;* James C. Spencer, Phelps, New York, May 27.

"The nature of my invention consists in forming the body of the carriage of two separate parts, and uniting them by side pieces, or any other suitable way, in such a manner as to form a joint at about the centre of the body; the front part of the body projects some distance over the back part, and is somewhat elevated, so as to form the seat, and to allow a spring to be placed under it, resting upon the back part underneath; the front and back parts are directly attached to the axles by body loops; the body is allowed to vibrate, and act upon the spring by means of the joint. By this arrangement, the construction of a carriage is simplified to a considerable extent, and can consequently be built at a much less cost, while, at the same time, it is equally as good, both for ease and durability, as the ordinary ones in use."

Claim.—"What I claim as my invention, is the manner of construction as described, viz: forming the body of two separate parts, united by a joint, which allows the body to vibrate and act upon a single spring, and also admits of a direct attachment of the body to the axles, substantially as set forth."

51. For an *Improvement in Excluding Dust from Railroad Cars;* Edward Hamilton, Bridgeport, Connecticut, Assignor to Nelson Goodyear, City of New York, May 27.

"The nature of my invention consists in providing each window of a railroad car, with vertical blinds or screens on the outside, extending the whole length of the window, to stand open in the direction in which the car is moving at an angle of about forty-five degrees with the sides of the car, by means of which a current of air is created from the inside of the car outward, thereby preventing the entrance of dust, cinders, smoke, &c., into the same."

Claim.—"What I claim as my invention, is the application of vertical blinds, shutters, or screens, on the outside of railroad cars, employing the same to prevent the entrance of dust, smoke, cinders &c., into the windows of the cars, as herein described."

52. For *Improvements in Hemp Brakes;* Paris M. Walker, Marshall, Missouri, May 27.

Claim.—"What I claim as my invention, is the combining a sufficient number of slats to break the full length of the hemp at once, in combination with the manner of feeding, substantially as set forth."

53. For an *Improvement in Self-weighing Machines for Grain;* William Biddle, Lafayette, Indiana, May 27.

"The nature of my improvements consists in the arrangement and combination of certain mechanical devices, by which the descent of a hopper, suspended to the ends of two arms, projecting from either extremity of a horizontal transverse shaft, shall simultaneously open a trap door in the bottom thereof, and close a hinge door attached to a receiving hopper, by the descent of a vertical rod, attached to the right side of the frame, and thus cut off the discharge of the grain therefrom, until the contents shall have been discharged from the suspended hopper, when said suspended hopper is made to rise by the action of a spring attached to an arm of the horizontal transverse shaft—and the receiving hopper made to tilt frontward in the arc of a circle by the weight of the grain therein, and close the trap door of the suspended hopper, by the descent of a vertical bar or rod attached to the left side of the frame, and simultaneously open the hinged door of the receiving hopper, when the grain will again descend to the suspended hopper, and the receiving hopper made to turn rearward by a weight, so that on the descent of the suspended hopper, the gauge plate shall close the hinged door of the receiving hopper, and so on, the operation being continuous, and the exact quantity of grain indicated by every descending movement of the suspended hopper."

Claim.—"Having thus described my self-weighing machine for grain, and shown the operation of the same, I desire that it shall be understood, that I do not claim a self-weighing machine, operated by the weight of the grain, so as to form an automatic weighing machine, by which, with the aid of a register or index, the amount weighed is ascertained. Nor do I claim opening a gate or door in the bottom of a receiving hopper by the descent of a steelyard, simultaneously with the discharge of the grain from a rotating hopper. But what I do claim as new, and of my own invention, is, the employment of the metallic plate C, or its equivalent, attached to the receiving hopper B, and made to rise and fall by the action of said hopper, and a gauge Q', in such a manner that on the *descent* of a suspended hopper F, the gauge plate Q, connected therewith, will disengage a catch plate (*f*,) from the right end of the metallic plate C, and permit the latter to fall, and cut off the discharge of the grain—and simultaneously therewith open a trap door H, in the bottom of the suspended hopper—and on the *ascent* of the same, the receiving hopper B, will be made to tilt frontward by the weight of the grain, so as again to raise the plate C, and open the hinged door D, of the said plate C, simultaneously with the closing of the trap-door, as fully described and represented.

"I also claim the employment of the gauge plate Q'. when combined with the lower or discharging hopper F, for the purpose of determining the quantity of grain to be weighed by limiting the descending movement of the suspended hopper F, and consequently gauging the action of the projection Q^2 on said gauge plate Q', to actuate the plate C, to cut off the discharge of the grain from the receiving hopper.

"I also claim the employment of the vertical pendant rods P R, confined to either side of the frame, when combined with a suspended hopper F, provided with a trap door H, for the purpose of opening and closing said trap door, by their descent alternately; said vertical pendant rods P R, being respectively actuated by the descent of the metallic plate C, to disengage the spring catch *t*, from the rod P, to open the trap door, and by the tilting frontward of the receiving hopper B, to disengage the spring bar O, from the vertical rod R, and allow its descent to close the trap door H, as set forth in the specification and shown in the drawings."

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54. For an *Improvement in Bran Dusters;* William A. McFarlan and Thomas C. Carpenter, Wilmington, Delaware, May 27.

"Our improvements consist of a combination of devices, by whose operation the bran entering the machine is thoroughly rubbed and scoured, and is equally distributed to a bolting apparatus beneath, by whose action the fine flour and bran are separated."

Claim.—"What we claim as our invention, is the combination of the scouring, beating, and distributing brush, with the perforated guard plate surrounding it, whereby the bran to be dressed is more equally distributed and fed to the bolt, than has been done by devices heretofore in use for the purpose."

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55. For an *Improvement in Planing Machines;* Nelson Barlow, St. Louis, Missouri, May 27.

Claim.—"Having thus fullyd escribed my improved machine for planing, tonguing, and grooving planks, &c., what I claim therein as my invention, is, 1st, The jointing or hinging of the plane stock supporting frame E J *f f*, or its equivalent, at one end, and giving it an elastic bearing at its opposite end, substantially as herein set forth; whether the said plane stock supporting frame be used in connexion with individually vibrating plane stocks, or with other descriptions of plane stocks, or planing knives, or cutters, for the purpose of reducing or planing planks or boards upon their sides or edges.

"2nd, I claim the combination of the supporting frame containing the adjustable plane stocks, H H, with the self-adjusting supporting frame containing the plane stocks, G G, by which the inner or under surfaces of the plane stocks G G, are made to form a self-adjusting bed on one side of a plank, whilst the knives in the stocks, H H, are operating upon and facing the opposite side of the same, and by which the inner or under surfaces of the plane stocks H H, are made to form an unyielding bed on one side of a plank, whilst the knives in the plane stocks, G G, are operating upon and reducing its opposite side; and by which a plank can be faced on one side and reduced and faced upon its opposite side at simultaneous operations, substantially as herein set forth.

"3rd, I claim the combination of the supporting frame containing the self-adjusting plane stocks, G G, with the arbor of the roller A at its forward end, and with the supporting frame containing the plane stocks H H at its rear end, for the purpose, in the first place, of so guiding the transversely reciprocating movements of the said plane stock supporting frames, as to keep the inner sides of the respective series of plane stocks contained therein, parallel with each other, and parallel with the surfaces of the pairs of rollers A A′, and B B′; and in the second place, for the purpose of enabling the supporting frame containing the self-adjusting plane stocks G G, to be detached from the supporting frame containing the adjustable plane stocks H H, and be swung outwards upon the shaft of the roller A, to afford free access to the inner sides of the plane stocks in both the said plane stock supporting frames, substantially as herein set forth.

"4th, I claim the combination of the rollers *d*, *d*, with the plane stocks G, G, when they are so arranged that the roller in one plane stock, will form a rotating and self-adjusting mouth piece to the planing knife that succeeds it, and at the same time form a bed on one side of a plank for a planing knife acting upon its opposite side, substantially as herein set forth.

"5th, I claim the giving to straight edged planing or reducing knives or cutters, that are arranged athwart the surfaces of the boards or planks operated upon, a transversely reciprocating movement, whilst a continuous longitudinal movement is imparted to the said boards or planks.

"6th, I claim the manner of producing a uniform elastic pressure upon the upper and lower bearing boxes of the arbors of the pressure rollers A, B, C, viz: by means of pairs of screws, *k*, *k*, arranged as herein described, and having threads inclining at angles of about thirty degrees with their axes, which are banded together and operated upon by a weight (N,) substantially as herein set forth.

"7th, I claim the within described improved stock that receives the tonguing, cutters *v*, *v*, and r r, composed of the central governing plate S, combined with the projections O, O, on the side plate Q, and the projections O″ O″, on the side plate R, substantially as herein set forth.

"8th, I also claim the manner of combining the stationary cutters v, v, with the governing centre plate S, by means of the inclined projections O, O″, on the sides of the said plate, the flaring notches in the plate and the gibs p, p, having lugs at each extremity placed in the said flaring notches, and acting upon the edges and front sides of the said cutters v, v, substantially as herein set forth."

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56. For *Improvements in Breech Loading Fire Arms;* Edward Maynard, Washington. District of Columbia, May 27.

"My invention relates to that class of fire arms which are loaded at the breech of the barrel, and consists of several distinct parts which are not necessarily used in connexion, but which, when so used, unite in forming a breech loading fire arm, containing certain valuable qualities not heretofore embodied in such an implement.

"The first part of my invention consists in combining with a musket or other fire arm, whose barrel is disconnected from its breech, and is pivoted to the stock at some point intermediate between its butt and its muzzle, a lever beneath the stock, by means of which the barrel is turned upon its pivot to raise and to depress its butt, which lever also locks the barrel to its breech when the butt is depressed, and unlocks it therefrom to allow the butt to be raised.

"The second part of my invention consists in combining with the improvement above specified, a piston breech pin, which by the movement of the lever in depressing the butt of the barrel and locking it in place, is made to move the cartridge forward in the barrel and to close the opening at the butt, which also by the movement of the same lever in unlocking the barrel, is made to open the butt, before the latter rises under the action of the lever. The remaining parts of my invention relate to the construction and arrangement of the several parts of fire arms, and are designed to add to their efficiency, while they at the same time enable me to alter and modify fire arms already constructed, and particularly the United States Government Musket, in such manner as to embody the improvements above specified with an increase in strength and durability."

Claim.—"What I claim as my invention in that class of breech-loading fire arms in which the barrel is disconnected from the breech and is pivoted at some point intermediate between its butt and its muzzle to the stock,is a lever beneath the stock, by means of which the barrel is turned upon its pivot to raise and to depress its butt, and is locked to its breech when the butt is depressed, and is unlocked therefrom to allow the butt to be raised, the several members of the implement being arranged and operating substantially as herein set forth.

"In combination with the above claimed device, I claim a piston breech pin, which by the movement of the lever to depress the butt of the barrel and to lock it in place, is made to move the cartridge forward in the barrel and to close the butt thereof, and which by the movement of the lever to unlock and raise the barrel, is made to unclose or open the butt of the barrel before the latter rises under the action of the lever.

"I likewise claim the sliding bolt constructed with slot and hook or their equivalents, and arranged as herein set forth, in combination with a lever handle for the purpose of imparting motion to the piston breech pin from the lever beneath."

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57. For an *Improvement in Boot Crimps;* Nathan Dawes and Higgins Harrison, Little York, New Jersey, May 27; ante-dated January, 31, 1851.

"The nature of our invention consists in so constructing and arranging the crimping plates upon a spring frame, that they will adjust themselves to any thickness of leather; and be capable of receiving any desired pressure that may be put upon them in the direction in which the creases are driven, as the tree which contains the leather is forced through said crimping plates."

Claim.—"Having thus fully described our invention, what we claim therein as new is, the combination of the spring frame crimping plates and boot tree with the adjustable side springs for the purpose of crimping boot fronts, and adjusting the pressure of the crimping plates to the particular point in which the creases have a tendency to run, the whole being arranged in the manner herein described and represented, or in any other manner essentially the same."

RE-ISSUES FOR MAY, 1851.

1. For an *Improvement in the Machinery for Manufacturing Felt Cloths;* J. B. Hyde, Assignee of Thomas R. Williams, Administrator, City of New York, patented December 14, 1840; re-issued May 6, 1851.

Claim.—"What is claimed as the invention of the said Thomas Robinson Williams, is the method, substantially as described, of forming the bat by the combined use of two endless aprons which receives the sliver from the doffer, or a carding engine, or otherwise, between them, and from the bat on one of the belts, whilst the other acts as a support, substantially as described."

2. For an *Improvement in the Machinery for Manufacturing Felt Cloths;* J. B. Hyde, Assignee of Thomas R. Williams, Administrator, City of New York, patented December 14, 1840; re-issued May 6, 1851.

Claim.—"What is claimed as the invention of the said Thomas Robinson Williams, is, "1st, The method substantially as described, of hardening the bat, by passing the same, between two series or tiers of rollers, covered with cloth, or otherwise, and arranged over each other, the one series being provided with a reciprocating endwise motion, for the purpose of felting the bat; and the other series with a progressive rotary motion, for the purpose of feeding the bat through, with or without the use of a trough containing hot water and soap suds, or other matter, substantially as described."

3. For an *Improvement in Cut Off, and Working the Valves of Steam Engines;* George H. Corliss, Providence, Rhode Island, patented March 10, 1849; re-issued May 13, 1851.

Claim.—"What I claim as my invention is, first, the method substantially as described of operating the slide valves of steam engines, by connecting the valves that govern the ports at opposite ends of the cylinder with separate arms of the rock shaft, or the mechanical equivalents thereof, so that from the motion thereof, the valve that keeps its port or ports closed shall move over a less space, while its port or ports is closed, than the one that is opening or closing its port or ports and vice versa, while at the same time, the two arms by which they are operated have the same range of motion as described, whereby I am enabled to save much of the power heretofore required to work the slide valves of steam engines, and by which also, I am enabled to give a greater range of motion to the valves at the periods of opening and closing the ports to facilitate the induction and eduction of steam as specified.

"And lastly, I claim the method of regulating the motion of steam engines by means of the regulator, by combining the said regulator with the catches that liberate the steam valves by means of movable cams or stops, substantially as described."

4. For an *Improvement in Door Locks;* Calvin Adams, Pittsburgh, Pennsylvania, Assignee of John P. Sherwood, Sandy Hill, New York, patented Dec. 17, 1842; re-issued May 13, 1851.

Claim.—"What I claim as my invention, is, making the cases in which the movements of locks and latches for doors are contained double faced, or so finished that either side may be used for the outside, in order that the same lock or cased fastening, may answer for a right or left hand door, substantially as described.

"I also claim the peculiar construction and double action (upon an inclined and horizontal track or way) of the locking car B as herein before described, and the combination of the locking car B, and safety cars g g^2 with one another, and with the connecting or vibrating bar and bolt A, as within described, so as to fasten the bolt c securely, and prevent its being picked."

5. For an *Improvement in the Jacquard Machinery for Weaving all kinds of Figured Cloth;* Alexander Calderhead, Philadelphia, Pennsylvania, February 3, 1841; re-issued May 13, 1851.

Claim.—"Having thus described my improvements in looms, and pointed out their application to looms for weaving carpets and other figured fabrics, what I claim therein as new, is, 1st, in connexion with looms for weaving figured fabrics, depressing the suspension board, or its equivalent, while the corresponding pattern card acting as a trap-board or its equivalent, is elevated, substantially as described.

"2nd, I claim working the card prism by mechanism connected with the loom, and whilst the boards or their equivalents for working the harness, are not opening and closing the shed, substantially as described."

DESIGNS FOR MAY, 1851.

1. For a *Design for Stove Doors and Panels;* Micajah C. Burleigh, Somersworth, New Hampshire, May 13.

Claim.—"What I claim as my invention is, the general arrangement and configuration of the ornaments and mouldings substantially as herein shown."

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2. For a *Design for Floor Oil Cloth;* James Hutchinson, Troy, New York, Assigned to Deborah A. E. and Nathaniel Powers, of Lansingburgh, New York, May 13.

Claim.—"What is claimed as my invention, is the arrangement of ornamental figures, forming a design for floor oil cloths, as shown in the aforesaid drawing."

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3. For a *Design for Clock Frames;* Nathaniel A. Batchelor, City of New York, May 13.

Claim.—"What I claim as my production, is the combination of figures, placed in the manner described, so as to form the front of a clock frame or case."

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4. For a *Design for Stoves;* James Wagar, David Pratt, and Volney Richmond, Troy, New York, May 20.

Claim.—"Having thus fully described our improvement and design, what we claim therein as new. is the foregoing described form and configuration of the plates, forming an ornamental design for a stove, as represented and illustrated by the drawings."

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5. For a *Design for Bedsteads;* Pelatiah M. Hutton, Troy, New York, May 20.

Claim.—"What I claim as my invention, is the designs and ornaments upon the parts A, B, C and D, combined as in the drawing hereto annexed."

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6. For a *Design for Stoves;* William L. Hathaway, of Dighton, Massachussetts, May 27.

Claim.—"What I claim as my production, is the new design, consisting of the several ornamental configurations and mouldings herein above described and represented in the drawings, for the side and front plates of a cooking stove."

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7. For a *Design for Stoves;* N. P. Richardson, of Portland, Maine, May 27.

Claim.—"What I claim as my production, is the design, consisting of the several mouldings, leaf work, and scrolls, herein above described and represented in the drawings, for the front, side, and back plates of a cooking stove."

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8. For a *Design for Stoves;* Ezra Ripley, of Troy, New York, Assigned, to Stafford & Co., of Troy, New York, May 27.

Claim.—"What I claim, is the design and configuration of ornamental stove plates substantially the same as described and represented."

JUNE.

1. For an *Improved Self-adjusting and Locking Switch for Railroads;* John C. Past, White Haven, Pennsylvania, June 3.

"The nature of my invention consists in providing certain counterpoise weights, or counterbalances (or their equivalent), upon the rock shafts on which the movable rails or treadles act, in combination with toggle levers, arranged with the other parts of the contrivance as hereinafter described, so that a secure lock to the switch, when moved into the desired position, is established and maintained, thereby rendering it not liable to be displaced by the oscillation or jarring of the cars; and a switch is produced which can be operated or shifted with certainty, by the weight of the cars."

Claim.—"Having thus fully described this form of self-adjusting railroad switch, what I claim as my invention, is the combination of the counterpoise weights, or their equivalents, with the toggle levers and stops, substantially as described, operating in the manner and for the purpose herein substantially set forth and made known."

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2. For an *Improvement in Comb-cutting Machines;* Horace S. Cook, Assigned to H. S. Cook and Seneca Colburn, Leominster, Massachusetts, June 3.

Claim.—"I do not claim the invention of a single chisel, made to operate by successive blows or cuts, each of which is in advance of another, and so as to create a series of cuts through a plate of horn or shell, such as will separate such plate into two combs, without what is termed a bottoming; that is to say, with the roots of the teeth of each of the said combs in a *straight* line, and not in a *curved* line, as they are when made with the 'bottoming.' Nor do I claim a die so made of stationary chisels or cutters (that is to say, those which are immovable with respect to one another), and for the purpose of enabling a person, by pressure of the *whole series* of cutters at once, against a plate of horn or shell, to separate it into two combs, either with or without a bottoming; but what I do claim as my improvement in comb-cutting machinery, the same consisting in making the cutters to operate or move separately and independently of each other, and in regular succession, in combination with making them of different and the required lengths, so as to produce the separation of two combs from a comb plate, substantially in the manner, and with the bottoming to their teeth, as herein before specified."

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3. For an *Improvement in Hand Machines for Spinning Wool;* Margaret Hulings, Randolph county, Indiana, June 3.

Claim.—"What I claim as my invention, is the clamp, the inclined planes, the lifter, the adjustable stop, the trip, the hand and ratchet, with the hand and ratchet combined and arranged as set forth and described, or any analogous device, for the purpose of spinning wool."

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4. For an *Improved Arrangement of Machinery for Actuating the Crank Indicator;* Samuel B. Hutchins, Oswegatchie, New York, June 3.

Claim.—"What I claim as my invention, is the arrangement of bevil wheels and their shafts, herein represented and described, the first in the series being actuated by a motion derived from the eccentric, by means of a crank and pin, and the last giving motion to the indicator hand; the whole being constructed in the manner and for the purposes herein set forth."

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5. For an *Improvement in Seed Distributors of Seed Planters;* David and Herman Wolf, Lebanon, Pennsylvania, June 3.

Claim.—"Having thus described our improvements on the machine for planting corn and other grain, what we claim therein as new, is, in combination with the notched transverse bar, the employment of the jointed cleavers projecting from the recesses of said bar into the apertures of slide bars T, for preventing the choking of the apertures."

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6. For an *Improvement in Collars for Harness;* Joseph W. Briggs, Cleveland, Ohio, June 3.

"The nature of my invention consists in constructing a self-adjusting draught collar, so arranged as to dispense with the cumbrous harness and collars now in use, and at the same time securing the same amount of strength and durability, causing the horse or other draught animals to draw a light or heavy load with more ease and facility than with other forms of collars now in use."

Claim.—"I do not claim, generally, the hame in one piece, with pads of limited length; but what I do claim as my invention, is, the U shaped metallic breast plate. suitably padded, and made to fit around the neck of the horse; the same being so limited in length, as not to reach the shoulder blades of the animal, and being suspended from the neck by a neck strap."

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7. For an *Improvement in Processes for Treating Vegetable Fibre;* Peter Claussen, Great Charlotte street, Blackfriars, England, June 3; anté-dated August 16, 1850.

Claim.—"What I claim as my invention and discovery, is, 1st, The preparation of vegetable fibre, capable of being spun or felted, by submitting the plant from which the fibre is to be derived, to the action of caustic soda, or other solutions of like properties, and then to that of sulphuric or sulphurous acid, in the manner set forth, whereby the gummy, glutinous, and other matters which connect the fibre with the woody portion of the plant, are dissolved and discharged; and at the same time effecting the discharge of the oleaginous and other coloring matters contained within the woody portions, or straw, without staining the fibre, as more fully described herein.

"2d, I claim splitting the fibres of vegetable matter, in preparing them for spinning, by the generation and liberation of carbonic acid or other gas, within the cellular portions of said fibres, in the manner described, or in any other manner by which gas may be generated and liberated, for the purpose set forth."

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8. For an *Improved Sash Stopper;* Joseph Osborn, Weymouth, Massachusetts, June 3.

"The nature of my invention consists in so arranging and adjusting a friction plate and spring, that the plate shall present two or three times as much frictional resistance to the motion of a sash downward, as to its motion upward."

Claim.—"What I claim as my invention, is arranging a sash stopper, composed of a friction plate, bolt, and helical spring, with the friction plate parallel to the side of the sash, and the bolt rising obliquely upward therefrom, in the manner herein set forth, so that the upward motion of the sash will relieve the same from the frictional resistance of the friction plate, by counteracting the force of said spring; and that the downward motion or tendency of the sash will augment the frictional resistance of said friction plate, by aiding the force of said spring."

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9. For an *Improvement in Horse Powers;* Cyrus Avery, Tunkhannock, Pennsylvania, June 3.

Claim.—"What I claim as my invention, is, 1st, The employment of rollers mounted or hung on the main shaft and lower guide shaft, in combination with the flanches on the wheels to retain said wheels upon their axles, when passing from one platform to the other, and to check their revolution as described."

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10. For an *Improvement in Machines for Expressing Cane Juice;* Henry Bessemer, Baxter House, &c., Middlesex county, England, June 3; anté-dated December 31, 1850.

Claim.—"What I claim as of my own invention, is, 1st, The extraction of the juice from cane, by submitting the stalks of the same in perforated tubes or other vessels, constructed on the principle described herein, to a continuous pressure, in the manner set forth, whereby time is afforded for the juice to flow from the cellular tissues, and re-absorption into the exhausted cane is avoided.

"2d, The perforated compressing tubes having either a straight or a tapering bore.

"3d, The combination of the pistons with the perforated tubes and hoppers, whereby the operations of regulating the feed, cutting the canes into equal lengths, pressing and discharging the same, are effected substantially as herein set forth."

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11. For an *Improvement in the Gearing of a Seed Planter;* Marshall J. Hunt, Rising Sun, Maryland, June 3.

Claim.—"Having thus fully described my invention, what I claim therein as new, is the combination and arrangement of the double bolt, with its slotted arm, rock shaft with its arms and pitman, for the double purpose of giving motion to the feeding apparatus, and also regulating the quantity of seed to be sown, when said pitman is operated by a long crank, upon which it travels, as herein fully shown and represented."

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12. For an *Improvement in Revolving Frames for Drying Fruits and other Articles;* J. C. Dickey, Washington, District of Columbia, June 3.

Claim.—"What I claim as my invention, in the above described portable frame, is the centre, with three or more arms, to support a cord, netting, or cloth, for the purpose of exposing cloths, clothes, glue, fruits, seeds, &c., with facility, to be dried; so constructed that the arms may be raised up and brought together, to expedite the collection of the articles dried, and so that it may be conveniently removed when not in use, substantially as described.

"I do not intend to limit my invention to the precise form of construction described, but to vary it, to suit the circumstances in which it is to be used, while I accomplish the desired object by means substantially the same."

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13. For an *Improvement in Ornamenting Baked Earthen Wares;* Ralph B. Beech, Kensington, Pennsylvania, June 5.

Claim.—"I do not intend herein to claim the general application of oil painting to china or earthenware, but what I do claim as my invention, is, 1st, The application of coloring matter, mixed with varnish or its equivalent to the surface of baked earthenware, for the purpose of giving to such ware a surface of sufficient body and of sufficient brilliancy for ornamental purposes, thus obviating the necessity of the glazing process, substantially as herein described.

"2d, The inlaying of pearls, gems, &c. on china and baked earthenware, for ornamental purposes, substantially as herein above described.

"3d. The peculiar cement and process, by which I affix pearls and gems to the china or baked earthenware."

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14. For an *Improvement in Carving Machines;* Lewis S. Chichester, Williamsburgh, New York, June 3.

Claim.—"What I claim as my invention, is the use of the pendent lever, suspended from a ball and socket joint, in combination with a horizontal table, for the pattern and block; the said table being affixed to the end of the pendent lever, by a ball and socket joint, the whole being arranged, with respect to the tracer and cutter, substantially in the manner and for the purpose described.

"I also claim preventing the pendent lever from changing its centre of motion, or from rotating on its own axis, or on any line passing through the centre of its motion, by the use of the bent arms working in balls in spherical sockets, substantially as described.

"I also claim combining with the pendent lever, two or more tables, substantially in the manner described, or in any other substantially the same, and arranged each with a tracer and cutter, respectively, in order that large carvings may be obtained from a small pattern, or vice versa, or both at the same time and with the same machine, substantially as described."

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15. For an *Improvement in Balanced Rudder;* Charles F. Brown, Warren, Rhode Island, June 10.

"My invention consists in the employment of two rudders, hung at a distance apart upon the same post, on each side; each of the two being at the same distance from the post, and with the surfaces of the one parallel, or nearly so, to the surfaces of the other."

Claim.—"What I claim as my invention, is, the employment, for the purpose of steering ships and other vessels in water, of two rudders hung upon and at equal distances from the same centre of motion, and with their surfaces parallel, or nearly so, with each other, in such manner that the same resistance is offered to each by the vessel's motion through the water, and both are balanced, substantially as herein described."

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16. For an *Improvement in Churns;* Davis Dutcher, Springfield, New York, June 10; anté-dated February 15, 1851.

Claim.—"Having thus fully described my invention, what I claim therein as new, is, the combination and arrangement of the arms, H H, with their rollers I I, which are controlled by the crank, and the swinging arms, G, G, with their floats *g*, *g*, kept in proper place, both in churning, and gathering and working the butter, by the resistance of the cream, as herein described and shown, and for the purposes herein represented."

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17. For an *Improvement in Comb Cutting Machines;* Thomas W. Hill, Leominster, Massachusetts, June 10.

Claim.—"I do not claim the mere use in a die, of a clearer for forcing out of the die, the article produced thereby; but what I do claim as my invention is, the combination of the two series of lifters, and bent levers, (arranged upon the traveling carriage,) with the pressure roller, in such manner, that the continued motion of the carriage shall operate the lifters after the combs are cut, substantially as herein before described."

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18. For *Improvements in Permutation Safety Locks;* Robert Newell, City of New York, June 10; ante-dated April 15, 1851.

Claim.—"What I claim as new and of my own invention and improvement, is, 1st, the application of the lever *b* 5, and dog *b* 6, with the tusk 40, to be acted on by the talon 39, and allow the spring 38 to throw the tusk 40 into the notches on the lower part of the followers, and auxiliary followers, so as to prevent any portion of these parts, if any of the tumblers are lifted after any end shake motion has been given to the bolt, by any improper attempt to unlock it.

"2nd, The combination of the tumblers *a*, slides *b* 1, and followers *a* 9, through the tenons 18, notches 30, tongues 29, and jaws 24, to lift the slides *b* 1, and followers *a* 9, to the same extent as the tumblers *a*, are lifted by the key sections on locking the bolt, and to sustain the slides *b* 1, until the tusk 33, takes the notches 31, on the slides, and holds them, so that the bolt cannot be retracted, until all the tumblers *a*, are lifted to meet the notches 30, and allow the springs 25, levers *a o*, and auxiliary followers *a* 8, to lift and place the followers *a* 9, in the same positions as when the bolt was projected, substantially as described and shown.

"3rd, The mode described and shown, of so arranging and combining the cylinder *c* 4, by the flanches *c* 5, angles 60, tumblers *c* and *a*, and pins 47 and 49, with the detector lever D, at the part *c* 1, as that no one of the tumblers *a*, can be separately lifted without placing the part *c* 3, of the detector lever over the key hole, with the edges of the notch 55, covering the open space around the drill pin 57, by which arrangement, no movement of the cylinder *c* 4, can be made without producing the same effect, so that if powder is introduced into the cylinder *c* 4, and the cylinder is moved, with the intent of entering a blow pipe, to spread the powder on either side of the cylinder, the part *c* 3, and notch 55, instantly cover the key hole and prevents the entry of the blow pipe for such a purpose; these parts being constructed, arranged, and operating, substantially as described and shewn.

"4th, The combination of the cylinder *c* 4, block 62, and hole 63, to receive and pass out any gunpowder put in for the purpose of exploding to destroy the lock, and at the same time prevent the powder from reaching any other part of the interior of the lock.

"5th, The application of the safety valve, block 64, to prevent the explosion of any gunpowder that may be confined in the cylinder *c* 4, by plugging both the key hole and the hole 63.

"6th, The mode of fitting the key hole cover *c* 3, with the notch 55, on the detector lever D, to match the neck 56 on the key shank, such means also preventing the introduction of any pick, or false instrument, after any movement has been given to the cylinder *c* 4, by the notch 55 being as small as the drill pin 57.

"7th, The application of the guard piece on the detector lever, to prevent a pick reaching the pin of the detent dog.

"8th, The application of the cam pointed piece on the detector lever to move the pin and detent dog attached, that if the key hole cover is cut or drilled off, the piece falls away, and leaves the detent dog still holding the bolt."

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19. For an *Improvement in Churns;* Ithiel S. Richardson, Boston, Massachussetts, June 10.

Claim.—"What I claim as my invention is, the combination of the rock shaft, levers, connecting rod, and swing for the churn, for the purpose of producing the perpendicular movement of the dasher, substantially in the manner herein described, to be denominated the oscillating perpendicular dash churn."

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20. For an *Improvement in Crossing the Fibres in Forming the Bats for Felt Cloth, &c;* Alonzo C. Arnold, Norwalk, Connecticut, June 10.

"My invention relates to a new and improved mode of carrying webs or sheets of fibrous materials, and when employed in the manufacture of felt cloth, is for the purpose of carrying the weft across, and depositing it upon the warp."

Claim.—"What I claim as my invention is, 1st, The employment, for the purpose of carrying webs, sheets, or layers, of any fibrous material, of an apron of material pervious to air, having a box, in which a vacuum is produced, placed at the back, the side of the box next the apron being perforated, or otherwise rendered pervious, so that the external air rushing through the apron to fill the vacuum within the box, forces the material close to the apron and confines it there, in combination with the manner herein described, of throwing off or releasing the materials from the apron by suddenly closing the valve in the pipe communicating between the box and the apparatus for producing the vacuum, and at the same time opening the valve in the said pipe, to admit air into the box, or by any means substantially the same.

"2nd, The flap operating in the manner and for the purposes substantially as herein specified."

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21. For an *Improvement in Governors;* George H. Corliss, Providence, Rhode Island, June 10.

Claim.—"What I claim as my invention is, making the method substantially as herein specified, of steadying the movement of governors or regulators of motion, by apparatus herein described, or the equivalent thereof."

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22. For an *Improvement in Railings;* Sommers Crowell, Reading, Pennsylvania, June 10.

Claim.—"What I claim as my invention is, making the dovetailed tenons, whether to the paling or top and bottom rails, wedge shaped in the length of the railing; the taper at the opposite ends being reverse, and making the grooves in the rails or palings in the same manner, that the palings cannot slide in either direction, binding the whole firmly together, substantially in the manner described."

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23. For an *Improvement in Machines for Facing and Polishing Stone and other Substances;* Albert Eames, Springfield, Massachussetts, June 10.

Claim.—"What I claim as my invention is, the method substantially as herein described, of grinding, facing, or polishing the surface of stones and other substances, by means of a grinder, rubber, or polisher, connected and combined with a spindle, from which it derives a rotary motion by means of universal and sliding joints, substantially as described, that the said grinder, rubber, or polisher, may be carried over any and all parts of the surface to be worked, whilst its surface is self adapting as described."

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24. For an *Improvement in Governors;* William Gardner, City of New York, June 10.

"The nature of my invention relates to the production of the same effects as are now performed by the ordinary pendulum, or centrifugal governor, and consists in hanging a pulley loosely on a counter shaft, which the pulley drives by band, or gear, from the main shaft, (or its equivalent,) through the pressure of a spring, or similar contrivance, on an arm secured to the counter shaft, the spring having its fulcrum fast to the pulley, so that any tendency to acceleration or retardation of the pulley, will, by its movement of 'lead,' or otherwise, on the counter shaft, through racks and pinions, operate the usual adjusting or regulating slide."

Claim.—"What I claim as my invention is, the employment of a loose wheel or pulley A, propelled by the prime mover, and driving its shaft B, through the action of a separate elastic force, weight, or pressure, such as procured by the spring H, in combination with the several racks and pinions. (or their equivalents.) as described, for operating the adjusting or regulating slide J, substantially in the manner shown and specified, and for the purposes set forth."

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25. For an *Improvement in Carriage Springs;* Chauncey H. Guard, Brownville, New York, June 10.

Claim.—"Having thus fully described my improvements in buggies, &c., what I claim as my invention is, the connecting of the axles of wheeled vehicles, by means of curved spring perches, which are combined with the supporting springs of the vehicles, that have a greater degree of curvature than themselves, substantially in the manner and for the purpose as herein set forth."

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26. For an *Improvement in Washing Machines;* Jo[illegible]'Neil, Xenia, Ohio, June 10.

"The nature of my invention consists in combining w[illegible]ever, a system of triple concentrating pressure (or compressing) blocks, for the purpose of more effectually squeezing the suds out of the clothes, during the process of washing."

Claim.—"What I claim as my invention is, t[illegible] and concentrated action of pressure blocks upon the clothes, being constructed and operated, substantially in the manner herein set forth and described."

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28. For an *Improvement in Lanterns;* Hugh and James Sangster, Buffalo, New York, June 10.

"The nature of our improvement consists in providing the lamps with two springs, each attached to its upper part, (one opposite the other,) and extending down nearly to the base of the lamp, when each forms an elbow; thence, passing under the lamp and terminating immediately below it, so as to permit the lamp to be removed from the lantern with ease and facility, by pressing horizontally upon the spring."

Claim.—"What we claim as our invention is, the mode of attaching the lamp to the lantern, by means of the springs and flanches, as herein substantially set forth."

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28. For an *Improvement in the Method of Finishing the Heads of Screws;* Thomas J. Sloan, City of New York, June 10.

Claim.—"What I claim as my invention in the method herein described, of finishing the heads, in the manufacture of wood screws, is partly shaving the head with a cutter, before nicking, and after nicking subjecting it to a second shaving operation, to complete the shaving by means of a cutter, whose edges form with each other a more acute angle than the edges of the cutter first employed, as herein specified."

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29. For an *Improvement in Centrifugal Sugar Drainers;* William Van Anden, Poughkeepsie, New York, June 10.

Claim.—"What I claim as my invention is, the contrivance for discharging, and at the same time cleansing the strainer, whilst in motion, by means of an elevator rising in a spiral groove, substantially as described; or, by an elevator rising in vertical or inclined grooves, which is essentially the same."

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30. For an *Improvement in Grain Harvesters;* Nicholas T. Allen, Ludlowville, New York, June 10.

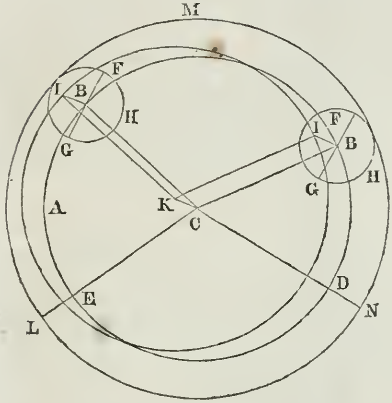
Claim.—"Having thus fully described my invention, what I claim therein as new is, gearing the operating parts of the machine from both the wheels, in combination with the arrangement by which portions may be driven by either, so as to equalize the driving power upon each, and thus allow the machine to be much more easily guided and controlled."

MECHANICS, PHYSICS, AND CHEMISTRY.

For the Journal of the Franklin Institute.

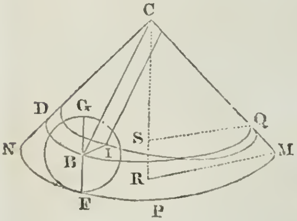
Investigation of Foucault's Experiment. By Charles J. Allen.

Fig. 1.



Let A B D E (Fig. 1,) be any circle, and C its centre; also let F H G be a circle, having its centre B on the circumference of the first circle. Then if the point B advance with a uniform motion along the circumference of the circle A B D E, carrying with it the circle F H G, in such manner that any diameter F G of this circle, shall preserve its parallelism, then it is evident that the circle F H G will have a retrograde rotation about its own centre, *relatively to the line joining the centres of the two circles*, and that the angular amount of this rotation during any given time, will be equal to the angle described by the radius C B in the same time; and further, if I be any point in the circle F H G, and if (I B being joined) I K, C K be drawn parallel to B C, B I, then as B advances, I B and K C continuing equal and parallel, K I and C B will also continue equal and parallel, and therefore the point I will describe a circle of which K is the centre, and K I ($=$ C B) the radius: this circle will therefore be equal to the circle A B D E; also, since the radii K I and C B continue parallel, they describe equal angles, and the points I and B *equal arcs*, in the same time.

Fig. 2.



Now with the centre C and distance equal to the sum of the radii of the two circles, or with any distance greater than this sum, describe the circle L M N, and draw the radii C L, C N cutting the circle A B D E in D and E. Then conceive one of the sectors thus formed, as for instance N C L M, to be rolled up so that the lines C L, C N shall coincide, thus forming the cone C N M, (Fig. 2, in which the same letters refer to the same parts as in Fig. 1.) Then the similar arcs L M N and E A B D (Fig. 1) will form complete circles of the cone, viz: the circles N P M and D B Q, respectively, whose radii will be the lines M R, Q S drawn perpendicular to C R, the axis of the cone.

If now the circle F H G have the same motions as before, both along the circumference of the circle D B Q, and about its own centre,* it is clear that the point I will trace the same line on this superficies, now that it is the surface of a cone, that it did when the same superficies was a plane; and that, consequently, the points I and B will, in any given time, describe *lines of equal length*, for it is evident that the relative position of the several lines on this superficies, *as reckoned along the superficies*, (not, however, their relative position *in space*,) must remain unchanged, provided we do not cross the line where the two edges of the sector L C N M unite. While, therefore, the circle F H G makes a complete revolution around the cone, its angular rotation about its own centre, relatively to the line drawn from this centre to the point C, will be the same as in describing the arc D B A E (Fig. 1,) but this, as shown above, is equal to the angle described by the radius B C, while B advances through the arc D B A E, that is, it is equal to the number of degrees in this arc: but this arc is equal to the circumference of the circle D B Q (Fig. 2). Hence, 360° : the number of degrees in the arc D B A E : : the circumference of the circle D B A E : the circumference of the circle D B Q : : the radius C B (= C Q, Fig. 2) : the radius Q S : : 1 : sin Q C S. Hence the number of degrees in the arc D B A E is equal to 360 × sin Q C S, which is therefore the angular relative rotation of the circle F H G, while performing a complete revolution around the cone.

Now let H = the angular revolution of the circle F H G around the cone for any given time, and x = the relative rotation of this circle about its own centre in the same time. Then, since x bears the same proportion to the rotation corresponding to a complete revolution, that H does to 360°, we have, $360° : H : : 360° \times \sin QCS : x$; whence, $x = H \times \sin QCS$.

Now let a pendulum, free to vibrate in any direction, be suspended over the centre of the circle F H G (Fig. 1), this circle having the two motions above described, and let the pendulum be made to vibrate across this circle by an impulse given it while in a vertical position. Suppose also the centre of attraction to be perpendicularly under the point C, and at such a distance that the resultant of the gravitating and centrifugal forces (and consequently the axis of vibration) shall always be perpendicular to the plane of the circle. Then it is evident that the ball of the pendulum will retain, in every part of its vibration, the orbitual motion or velocity due to the point B; and since, as has been proved above, every point in the circle F H G has this same orbitual motion, viz: that of the point B, it follows that the pendulum and the several parts of the circle F H G, have (irrespective of the vibration) *the same absolute motion*, and are therefore RELATIVELY AT REST, *except the motion due to the vibration alone.* Hence the pendulum will move with respect to this circle as if the two were *absolutely at rest*, that is, it will describe a straight line across the circle, and the same line at each successive oscillation, the plane of vibration performing, with the circle F H G, a retrograde revolution about its axis, relatively to the circle L M N, its angular relative rotation in any given time being equal to its angular orbitual motion in the same time. This result might have also been deduced directly from the fact, that the plane of vibration must, under the circumstances supposed, maintain its parallelism; but the above method has been followed as being equally applicable to this and the following case.

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* Although the circle F H G is no longer a true circle *in space*, it is a true circle as reckoned along the conical superficies; nor is this rotation, strictly speaking, a rotation *in space*, but a rotation on the surface of the cone, in such manner that any point in the circle shall preserve a uniform distance (as measured along the conical surface) from the centre B.

Now let the pendulum be suspended over the centre of the circle F H G on the surface of the cone C N M (Fig. 2), and let this circle have the motions supposed above: also let the pendulum be made to vibrate as before, the gravitating and centrifugal forces being such that the resultant of these forces shall be perpendicular to the superficies of the cone in every part thereof. Then, as in the previous case, the ball of the pendulum, having a certain orbitual velocity, will maintain this same orbitual velocity in every part of its vibration, that is, the velocity due to the point B, which is also the velocity of every and any point in the circle F H G. Hence (the circle F H G being supposed so small, compared with the cone, that the conical superficies included within it may be regarded as a plane*), we see that in this case also the pendulum and the several parts of the circle F H G will be *relatively at rest*, excepting only the vibratory motion; and consequently the plane of vibration will, as before, always intersect this circle in the same straight line, that is, *it will revolve on its axis with this circle.*†

It is manifest from what has been shown above, that the system of radiating curves described by the pendulum on the circle L M N (Fig. 1), and on the surface of the cone D E F (Fig. 2), is the same as would be described if the axis of vibration, and the plane of vibration, were *fixed* in space, and the circle L M N in the former case, and the cone D E F in the latter, were to rotate about this axis with a uniform angular velocity.

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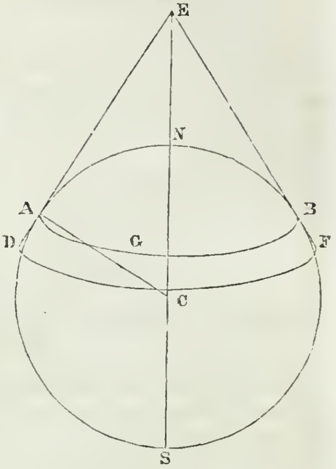
* When the conical superficies included within this circle varies sensibly from a true plane, the only effect is, that the velocity of rotation of the plane of vibration is not *uniform*; the *mean* velocity, however, is not affected.

† This reasoning is not strictly correct, unleſs we suppose the ball of the pendulum, or, more correctly, the centre of this ball, to move in a plane parallel to the circle F H G, or in other words, unless the arc of vibration be considered a straight line, (a supposition manifestly inadmissible;) for, the higher parts of this arc being more remote from the axis of orbitual motion than the lower parts, have a greater orbitual velocity. Hence arises an irregularity in the rotation of the plane of vibration. But a little examination of this point, will show that the only effect is an *oscillatory* motion of the plane of vibration about its axis, this motion being in the *same* direction as the rotation, while the ball of the pendulum is over that half of the circle F H G which is towards the base of the cone, but in a direction *contrary* to the rotation, while the ball is over the half of F H G which is towards the apex of the cone. These motions, being equal, balance each other, and therefore the *mean* rate of rotation is not affected. Moreover, the amount of this oscillation, even when at its maximum, especially if the pendulum is a long one, is exceedingly small. This source of irregularity may therefore be entirely disregarded in the above investigation.

Fig. 3.



Now let A N B S (Fig. 3) be the earth, C its centre, N and S the poles, A any place on its surface, and A G B the circle of latitude of that place. Also let E D F be a cone touching the sphere in the circle A G B, and having its vertex at E in the prolongation N E of the axis S N. Join A C: then E A C is a right angle; and since A C E is the co-latitude of the place A, A E C is the latitude, which put = L. If now a pendulum vibrate at A, while the earth revolves on its axis S N, the case is that of a pendulum vibrating on the surface of the cone D E F, and revolving around that cone in the circle A G B, parallel to its base. If then, H = the angular rotation of the earth in a given time, and x = the corresponding angular rotation of the plane of vibration relatively to the line joining A and E (i. e. relatively to the meridian of the place), the result deduced above gives us the equation $x = \text{H} \times \sin \text{A E G} = \text{H} \times \sin \text{L}$: which is the result obtained by the French mathematicians.

It is evident that the ball of the pendulum will always present the same face towards the same points of the compass, since it has, at the commencement of the experiment, the same *virtual rotation* about the axis of vibration, as the surface of the earth beneath it. In making the experiment, therefore, it is of no advantage to suspend the wire in such manner as to turn freely in a horizontal direction.

In the foregoing investigation, the pendulum is supposed to vibrate from an impulse given it while in a vertical position: if, however, it be started at the circumference of the circle F H G, the ball having the *orbitual* motion of the point from which it commenced its vibration, then instead of describing a straight line across the circle F H G, (this circle rotating in a retrograde direction, as above supposed,) it will describe an oblong curvilinear figure about the centre B, which figure will be the result of a *compound vibration* composed of two cross vibrations, one the main vibration, the other in the direction of the orbitual motion, (that is, in the direction of this motion across the circle F H G at the time of commencing the experiment,) the latter vibration being occasioned by the difference in the orbitual velocity of the starting point, and that of the centre B. The form of this curvilinear figure will evidently approach to a straight line, according as the direction of the main vibration approaches that of the orbitual motion. A short investigation founded on the well known principles of the pendulum, shows that the chord of the arc of orbitual vibration is found by the following formula, in which y = half this chord, r = radius of the circle of vibration (= half the chord of the main vibration), l = length of the pendulum (in feet), and

$a =$ the angle contained between the meridian and the line representing the initial direction of the first vibration, viz:—

$$y = \frac{r \text{ sin. L cos. } a}{77787} \times \sqrt{l}$$

Hence when $a = 0$ $y = \frac{r \text{ sin. L}}{77787} \times \sqrt{l}$, whichis there fore the equation for the semi-minor axis of the figure described on the circle F H G, by a pendulum started from the most northern or the most southern point of that circle.

Philadelphia, 6*th mo.*, 1851.

For the Journal of the Franklin Institute.

Remarks on Nystrom's Screw Propeller. By B. F. Isherwood, *Chief Engineer, U. S. N.*

As the subject of the Screw Propeller is, at the present time, one of the most interesting in mechanics, and has not yet, to our knowledge, been satisfactorily treated, we give with great pleasure, Mr. Isherwood's criticisms on Nystrom's Screw, published in our May Number—omitting, as is our custom, those passages in which the author has thought proper to use personal and insulting language, for which, we repeat, there is no room in our Journal.—Ed.

I have read in the May number of the Journal, a "Description of a Screw Propeller, patented by John William Nystrom," March 19, 1850, which, as it has found a place in the Journal, appears worthy of a few remarks.

The peculiarity of Mr. Nystrom's Screw, consists in the formation of the helicoidal surface by a *curved generatrix*, instead of a *straight generatrix*, as usually employed.

It may be necessary to define what is meant by a generatrix. Let any right line whatever be taken and called the *axis of the helicoid* or screw, and let any other line curved or straight of definite length be taken, lying at any inclination to the axis, and with one extremity touching the axis; this line is the *generatrix of the helicoid* when it is moved simultaneously with a rotary speed around the axis, and a rectilineal speed along the axis.

As previously remarked, Mr. Nystrom uses a curved line for the generatrix, instead of a straight line, as usually used; and the object of using the curved generatrix, is to prevent the alleged loss of effect, caused by the centrifugal force imparted by the rotary motion of the helicoidal surface to the particles of water with which it is in contact. Before proceeding to cure an alleged evil, it may be advisable to ascertain if it exist, and to what extent.

If the helicoid had no slip, and moved through the water a distance equal to its pitch per revolution, there evidently could be no centrifugal force communicated to the water in contact with it, for as the helicoid continuously advanced, it would no sooner press any molecule of water, than the pressure on that molecule would be removed by the advance of the helicoid. The helicoid, in this case, would be in contact with the molecule but an infinitely short time, and of course could endow it with no centrifugal motion. But if the helicoid have slip, the effect of that slip is to keep the molecule of water in contact with the helicoid for a time proportional to the slip, and, consequently, to endow it with a proportional centrifugal force. If the slip be considerable, the throwing off of the water at the periphery of the helicoid may become sensible, in consequence of that force and the property of the water to escape by the easiest road. This effect was observed in the experiments of Taurines, which were performed on *fixed* screws, not advancing rectilineally, but having only a rotary motion on the axis; by which arrangement the slip amounted to unity. The amount of centrifugal force imparted to the particles of water by the rotating helicoidal surface in contact with them was, however, very trifling, even under the most favorable condition of maximum slip; for the very effect of that slip was to discharge the water from the helicoid, the vacuity being filled by fresh water flowing in. Having thus determined the existence of a small amount of this centrifugal force, and the conditions of slip modifying it; let us inquire whether, even in the event of the amount of this force becoming considerable, there would result any loss of effect.

And, first, what would be the nature of that loss of effect, if any existed? It would be shown in the *increased slip of the screw* for the following reason. The water being thrown off radially in all directions from the axis, by the centrifugal force communicated to it by the revolving screw, there would be a vacuum about the axis, provided the centrifugal force forming the vacuum exceeded the force with which the surrounding water would flow in to fill it, and the resistance to the screw would be decreased in proportion to the extent of this vacuum; that is, the slip of the screw would be increased. *The loss of effect therefore due to this centrifugal force, would be measured by the increased slip of the screw.* But if the water flowed into the vacuum as fast as it was formed, the resistance to the screw would evidently remain the same as though there were no centrifugal force in action; and this is what actually occurs in practice. Let it then be considered the depth to which the axis of a 13 feet diameter screw (mean size) is immersed, and the consequent pressure of water about it, and then the slips found in practice, ranging from 15 to 30 per cent. for maximum, and it will be seen how enormously the effect of any centrifugal force must be exaggerated, to make it productive of a vacuum at the axis of the screw. Supposing now a centrifugal force to be given to the molecules of water in contact with the helicoidal rotating surface, of any amount less than requisite to produce a vacuum at the axis: would it be attended with loss of effect by the screw? Evidently not, for the following reasons.

With a straight generatrix touching the axis, the lateral component of the oblique surface of the screw is tangential to a cylinder, by which the screw may be supposed to be enveloped; or is at right angles to the radii of that cylinder. With a straight generatrix touching an inner cylinder, having a common axis with the screw, the lateral component is no longer at right angles to the radii of the enveloping cylinder, but either converge to, or diverges from, the axis, as either the acute or obtuse angle is used for propulsion. In both cases the component in the direction of the axis continues the same; that is, parallel to the axis. Now, it is the component in the direction of the axis that alone propels; hence, the slips of screws of the same diameter, pitch, and length, but the one having a straight generatrix touching the axis, and the other a straight generatrix touching tangentially a cylinder having the same axis as the screw, should be the same. The only effect, then, of converging the lateral component to, or diverging it from the axis, is, to cause a flowing of water to or from the axis, proportioned to the obliquity of the lateral component to the axis, and as this component does not affect the propulsion, it is obviously of no importance what be its direction. There can be no loss of labor attending it, for as all angles are in function of form, equally efficient for propulsion, consequently, their components are equally so. The same slip, or, in other words, the same resistance, is obtained from the water, with screws of equal diameter, pitch, and length, whether they have straight, inclined, or *curved* generatrices: for the curved generatrix is obviously but a modification of the inclined generatrix; that is, it is an inclined generatrix, whose inclination momentarily changes. It is therefore governed by the same principles.

There is, however, a *practical* disadvantage and loss of labor attending the use of a curved generatrix, though none theoretically, that is, in function of form: for the friction of the helicoidal surface on the water, which in differently proportioned screws ranges from 10 to 20 per cent. of the power applied; being as the surfaces with equal speeds, and the surface of a screw of given diameter, pitch, and length, or fraction of one convolution of the thread, is greater with the curved than with the straight generatrix, because an arc of a circle is greater than its chord; it follows then, that in otherwise similar screws the greater the curvature of the generatrix, the greater the loss by friction. The only real loss of power attending the imparting of a centrifugal force to the molecules of water, is that due to their momentum, that is, will be expressed by multiplying the weight of water, to which centrifugal force is imparted by the square of the speed, with which it flies off radially from the centre. In the most favorable case of maximum slip, that is, a slip of unity, this product would be an almost insensible proportion of the total power applied.

From the foregoing, then, it will be perceived that a curved generatrix, so far from being advantageous, is positively a disadvantage; nor is it necessary to depend entirely on induction for this opinion; for it has been fully confirmed by experiment. About the year 1847, (I give the date from memory,) a series of the most complete experiments were made by Bourgois, by order of the French government, on a vast number of screws of different proportions and shape, among them the form of screw (i. e. with a curved generatrix) afterwards patented in this country by Nystrom. These experiments were made with great sagacity of method, and determined most satisfactorily the total uselessness of a curved generatrix. I give the condensed results of the experiments, which will be the first time they have appeared in an English work.

It was perfectly comprehended by Bourgois, that in order to make the influence of a curved generatrix sensible, it would be necessary that the screw have a very considerable slip; its surface during the experiments, was therefore sufficiently reduced to satisfy this condition. To fully test this influence, the screw was first tried, propelling with the convex face, then tried propelling with the concave face, and lastly tried after the flexure had been taken out of the generatrix, that is, after the generatrix had been made straight.

The results are as follows:

Time.	*Conditions.*	*Slip of Screw.*	
		per cent.	
March 4.	Strong breeze, river rough, propelling with the convex face of the screw. Mean of six experiments.	50·2	With curved generatrix.
Same day, same time.	Propelling with the concave face of the screw. Mean of six experiments.	49.3	
March 19.	Calm. Propelling with the convex face of the screw. Mean of six experiments.	44·4	
Same day, same time.	Propelling with the concave face of the screw. Mean of six experiments.	47·6	
March 20.	Calm. Propelling with the convex face of the screw. Mean of four experiments.	45·4	
Same day, same time.	Propelling with the concave face of the screw. Mean of four experiments.	48·8	
Same day, same time.	The same screw having the generatrix made straight. Mean of eight experiments, four being made on each face.	51·2	With straight genera'x.

Allowing for unavoidable errors of observation, dimensions, &c., in experiments of this nature, it will be observed, that sensibly the same result was obtained, propelling with either face of the curved generatrix and the straight generatrix, showing that the employment of a curved generatrix was at least useless, even with the exaggerated slip of 50 per cent.; 30 per cent. being the maximum in practice.

After reviewing some experiments carefully made on other screws, for the purpose of determining the effect of a curved generatrix, Bourgois remarks, which I translate as follows:

"In the second place, if we observe helicoidal surfaces with curved generatrices, or what amounts to the same thing, generated by a straight line inclined on the axis, we perceive the liquid threads do not rest on the same helicoidal thread. As the periphery of the screw is approached, the helicoidal thread inclines its propelling surface towards the axis, and the liquid thread keeping at rest in the normal plane, inclines itself slightly towards the centre; there, on the contrary and for the same reason, the liquid threads tend to remove themselves from the axis, but being endowed with less momentum than the first, there results a flowing of water towards the centre of the screw with so much the more abundance as the curvature of the generatrix is greater. This is the only notable effect resulting from the employment of a curved generatrix; and there is nothing to prove that effect favorable.

The experiments made on screws B 7 and B 8,[*] show, on the contrary, an increase of slip of 04·7, proving that the employment of curved generatrices directs the water towards the axis in consequence of their obliquity.

The experiments on screws ϕ_3 and ϕ_4 under similar conditions, gave sensibly the same result, either the water was pushed towards the axis, or it was deflected out towards the periphery.[†]

Finally, in passing from screw Ω to Ω_1, the slip increased 07·5."[‡]

The experiment of Sabloukoff, on a screw turned in air, and having the phenomena made visible by smoke, also corroborates the above. It was found that, after a high rotary speed had been given to the screw, the smoke being then let on at its anterior extremity, at any point *near its periphery*, was drawn towards the screw, and carried towards the other extremity. When let on at its anterior extremity, *near the axis*, the smoke coursed along parallel to the axis, without any appearance of having a circular movement, and which was the same in the first case; spreading out from the axis, which should have been the case had the rotation of the screw been able to give a *sensible* centrifugal force to the smoke.

But even supposing, (which we have seen is far from being the case,) that the centrifugal force communicated to the particles of water in contact with the propelling surface by its rotary movement, were great enough to produce so sensible a result as a vacuum at the axis of the screw equal to a diameter one-fourth the diameter of the screw, and supposing the use of a curved generatrix to wholly obviate this, or restore solid water in the place of the vacuum; even then the employment of a curved generatrix would be useless as far as the reduction of the slip of the screw is concerned, and this fact also depends on the carefully conducted experiments of Bourgois. In those experiments there were tried two screws, exactly alike, excepting that the one had a projected area at right angles to axis, of 187·86, while the other had a similar area of 182.59, the reduction being made by cutting out the surface immediately around the axis. The diameter of the screws was 15·752, and the diameter of the cut out part of the last screw was 3·938. The slip of the first was 35·2 per cent.; of the last, 32·6 per cent. Similar experiments on two other screws, differing from the above in pitch only, gave with the full screw a slip of 26·9 per cent., with the cut out screw 24·4 per cent. On these experiments Bourgois remarks, which I translate as follows:

"The difference (between the slips) being little enough to be attributed to irregularities of construction or slight errors in the observations, nothing can be concluded from it, except that a hollowing out, of which the diameter is equal to the fourth part of the exterior diameter of the screw, has no influence on the slip."

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[*] Which were precisely alike, and formed with the generatrix tangent to an inner cylinder, which is virtually a curved generatrix. B 7 propelled with the obtuse or convex face, and gave a slip of 26·1 per cent. B 8 propelled with the acute or concave face, and gave a slip of 30·8 per cent., or 4·7 *per cent. more.*—B F I.

[†] Screws ϕ_3 and ϕ_4, were precisely alike, and formed with the generatrix tangent to an inner cylinder. Screw ϕ_3 propelled with the obtuse or convex face, and gave a slip of 32·8 per cent. Screw ϕ_4 propelled with the acute or concave face, and gave a slip of 33 per cent.—B F I.

[‡] Both screws being precisely alike, except that screw Ω had a straight generatrix; and gave a slip of 34·5 per cent., while screw Ω_1 had a curved generatrix, and gave a slip of 42· per cent.—B F I.

Believing that sufficient has been written to put this subject in a true light, there only remains to notice a few of Mr. Nystrom's statements. And first he says:

"The water between the blades is acted upon at the same moment by two forces, the one being the propulsive force resulting from the oblique action of the revolving blades, and the other being the centrifugal force generated by their rotation, the first force tending to force the water backwards *in directions parallel to the axis* of the propeller." This is erroneous, the water forced backwards by the blades of the screw is *in directions at right angles* to the surface of those blades; no fact in hydrostatics being better established than that fluids are *always* pressed in directions at right angles to the pressing surface.

Mr. Nystrom gives the slip of screw propellers for ocean steamers at 50 per cent. This is not the fact, 30 per cent. being the maximum, and any screw giving a greater slip, should be immediately (and would be) changed for another of better proportions, giving the proper slip of about 25 per cent., which gives the minimum of the losses of labor by slip and friction of the screw surface on the water.

Mr. Nystrom also recommends the employment of bands for strengthening the blades, to be applied at the *periphery* of the screw. Now the propriety of using bands at all results from the fact that the water acted upon by the blade in its lowest position, offers a greater resistance on account of its greater depth than the water acted upon by the blade in its highest position, but the blade must possess strength enough to withstand the greater resistance; if, therefore, the excess of strength which it would have when subjected to the less resistance, could be applied to it when subjected to the greater resistance, a less strength of blade would answer. In the common paddle wheel, this is effected by bands or rings uniting the extremities and intermediate points of the arms or radii bearing the paddles, and Mr. Nystrom adopts the same system for his screw propeller, without, however, recognising the important difference, that the reaction on the paddle-wheel arms is at right angles to those arms, and *directly in the line of the uniting rings*, while the same reaction on the blades of the screw being at right angles to the helicoidal surface of those blades, and that surface being oblique to the axis of the screw, and not in the same direction as in the paddle-wheel, the reaction would not be at right angles to the axis, and as the rings or bands are placed at right angles to the axis, *would not be* in the line of the bands, but oblique to them, so that the bands, instead of being subject to a strain in the direction of their length only, would be subject to an additional cross strain, and in proportion to the sines of the angle of obliquity of the blades. To resist this cross strain, the bands would have to be impracticably large; and if not made strong enough for this strain, they are useless. Furthermore, if used at all, the bands ought evidently not to be applied to the periphery of the blades, but to the centre of effort of the blades. They are, however, a totally unnecessary and worthless appendage to any submerged screw.

When the date of Bourgois' experiments are considered, so far antecedent to Nystrom's patent, it is really amazing that our patent office should have granted a patent without novelty; but as I apprehend no one will ever be found to use it, so the issuing of the patent will do no harm to any but the inventor, who suffers to the extent of the patent fees and cost of model, &c.

For the Journal of the Franklin Institute.

Sketch of the Invention of Parker's Water Wheel. By Z. Parker.

In the year 1825, Z. G. & A. Parker, brothers, were in partnership, erecting mills in Cashocton county, Ohio, on Wills Creek, a navigable stream, much subject to "back-water." Having started a flutter-wheel saw-mill in July of that year, it was found, from freshets occurring frequently, and the known character of the stream, that the wheel would be flooded, and the mill consequently inoperative a great portion of the time.

To remedy this disadvantage in a second saw-mill in the same building, it was contemplated to build a geared re-action mill, such as were common at the time. But these mills being expensive, and hard to keep in working condition, this arrangement was not very satisfactory. In the latter part of august, Austin Parker suggested the idea of avoiding gearing, and making a wheel that would run under water, by arranging a number of small re-action wheels vertically on a horizontal shaft, to occupy the same position as the flutter-wheel. After due consideration, this suggestion was approved, and in November, a pattern for cast-iron buckets for such a wheel was made by myself, and taken to a foundry in Zanesville to be cast. The castings were got to the mill in February, 1826; and in March or April, the construction of the wheel, consisting of six (two double and two single) small re-action wheels, 28 inches diameter, was commenced. In November, the arrangement was so far completed, as to admit the application of the water, as an experiment to enable us to judge of the power and speed of the wheel. The result indicated an entire failure, the wheel only making about 80 revolutions per minute, running free, when at least 180 were expected; and it was held with a slight resistance to its motion.

In consequence of this failure, the work on the new saw-mill was suspended, and our attention turned to the erection of a flouring and grist-mill. For this, a common re-action wheel was made, which was put in operation in the fall of 1827. While at work at it, and before the gearing was attached, a small stream of water was admitted to pass through it, which was slowly turning it. The water, in consequence of the direction of its approach, fell into the wheel with a vertical or whirling motion, which was in the direction contrary to the motion of the wheel. A plank by accident fell into the penstock, and lodged in a position which changed the direction of the water, so as to cause it to enter with a circular motion, coinciding with the wheel's motion. The wheel was at once observed to start off with nearly double its previous speed. The plank was removed, when it again relaxed to its former motion; and by frequently trying the experiment with the plank in and out of the place where it lodged, it was satisfactorily ascertained, that the wheel had nearly double the speed and power, when the water entered it revolving with it, as when in the contrary direction.

This discovery brought to light an error which had been committed, in the introduction of the water to the saw wheel, which was inadvertently made such as to cause it to enter whirling the wrong way; and the confident hope was then revived of yet making it successful. Accordingly, in the summer and fall of 1828, such alterations were made in the adductive passages as would cause the water to enter the wheel with a lively circular or helical motion, coinciding with the revolution of the wheel. On introducing the water, the success was found to be complete; and the same wheel, which with the water entering the wrong way, made only 80 revolutions per minute, now made 280, and apparently with great power. This trial was made in the latter part of October.

In November, with a view of an experiment in applying the principle more perfectly, a small re-action gig-wheel was made, (for backing the log-carriage of the same mill,) with such modifications in its form and proportions as were thought to be necessary to adapt it to the new mode of action of the water, to which the first helical sluice, in the form represented in the patent, was applied. Its speed and power were beyond our most sanguine expectations.

The saw-mill was got fully into operation in December, 1828, and such was the success, that with an aggregate orifice of 250 square inches, on a fall of 5½ feet, the new wheel would saw 3000 feet of boards in a day; while the flutter-wheel, (which was considered a good one,) with a gate of supply of more than 450 square inches, would only saw 2000 feet. The alteration of the saw-wheel, and the planning and construction of the gig-wheel, were done almost entirely by myself, and under my directions.

The "new idea" of the "draft boxes" originated with Austin Parker, then in Portage County, Ohio, early in 1833; and he made a number of experiments to satisfy himself of the practicability of the principle, and applied them imperfectly and experimentally to several mills, and was making further experiments in their application at the time of his death in October, 1834. Further investigations and experiments, and the final perfecting of this part of the invention, was done subsequently by myself.

The beautiful and interesting experiment which manifests the law of the centrifuge and equilibrium of a mass of water, or other fluid, revolving within a vertical cylinder, variously changed and repeated, so as certainly and fully to establish the truth of the deduced law, was made by me in Licking County, Ohio, in January, 1841, and a notice of it with a diagram, together with various statements, drawings, and models, relating to the invention, was sent to the Franklin Institute, in May of the same year.

An extensive set of experiments was also made at the same place in April, 1844, for the purpose of ascertaining the true value of the circular motion of the water, in its application to re-action wheels, and the superiority of the improved form of the wheel over the old; and a paper containing a tabulated statement of the results was presented to the Institute in the May or June following.

The change in the form of the orifices and curves of the wheel, from the original square issue, was done progressively by both the inventors from 1832 to 1838.

The adaptation of the improvements to great powers on high falls, has occupied much of my time during the last three years; the plan has been finished as far as it can be, without further practical experiments, for nearly a year.

A great variety of experiments were made during the progress of the invention, involving much time, expense, and thought, particularly in 1827 and 1828, for the purpose of ascertaining the most advantageous mode, and the best forms and proportions, for producing and applying the vertical motion of the water, previous to preparing the specifications and applying for the patent; and also in 1833-4-5 and 6, in studying, arranging, proportioning, and perfecting, theoretically and practically, the "drafts."

For the Journal of the Franklin Institute.

Dimensions of the Engines and Vessels of Steamers Pioneer and City of Pittsburg.

I have the pleasure of sending herewith, the dimensions of the engines and vessels of steamers Pioneer and City of Pittsburg, intended for the Liverpool trade, now building in this city. The Pioneer, from the yard of Mr. J. Bell, is a ship of easy lines, though by no means sharp. The City of Pittsburg, from the yard of Messrs. Perrine, Patterson & Stuck, has more floor and is much fuller, yet sharp at both stem and stern.

The engines of each vessel are double vertical trunk engines of the same dimensions, compact in form, and heavily built for their power. As similar engines have been before constructed, there can of course be no claim to originality, but the combination and adaptation of the various improvements which have been from time to time made upon marine engines, is justly due to Mr. Frederick Rumpf, the engineer of the establishment.

	Pioneer. Feet.	City of Pittsburg. Feet.
Length of vessel,	230	245
Width of beam,	38	38
Depth of hold to keel,	31½	33
Space occupied by engines in length of vessel,	21	21
Length of boilers, (double return drop flue),	29	30
Width of boilers,	16	11 3 in.
Height of "	10	12
Number of "	two.	three.
Diameter of steam cylinders,	85½ in.	85½ in.
" " trunk,	39 "	39 "
Length of stroke,	51 "	51 "
Diameter of journals of propeller shaft,	16 "	16 "
Diameter of propeller,	16	16
Face of "	5	5
Pitch at periphery,	34	36
" " hub,	27½	29½
Number of blades in propeller,	three.	three.
Height of trunk above keelsons, on up stroke,	21	21
Calculated number of revolutions,	36	36

The Pioneer will probably make her trial trip early in the ensuing month, and the City of Pittsburg, not yet launched, will be completed in the month of September, when the effective power of the engines, speed of vessels, and the difference in the pitch of the propellers, be fully tested. K.

For the Journal of the Franklin Institute.

Notes on the U. S. Steam Propeller Legaré, with remarks on the Relative Advantages of the Propeller and Side Wheel.

The steamer Legaré was originally built for the revenue service, and subsequently transferred to the Navy Department for the use of the Coast Survey—is built of iron, of the following dimensions: 140 feet long, 24 feet beam, depth of hold 11 feet: a three masted schooner, rigged with fore-topsail; has one beam engine (condensing, sitting athwart ship; diameter of cylinder 32 inches, stroke of piston 36 inches. When these notes were taken she had an Ericsson's propeller of the following dimensions, viz:

	Feet.	*Inches.*
Diameter,	9	6
Length of blades,	4	1
Width of blades,	2	½
Length of inclined plane of screw,	36	
Diameter of drum,	5	6
Width of drum,		18
Pitch of inclined plane of screw,	21·75	

Six of them, whose combined length is less than one convolution of the screw by 5·24 feet.

The data was taken from the results of 10 hours steaming under the most favorable circumstances of wind and sea, in the Chesapeake Bay. Wind calm, sea smooth, engine working well, making an average of 31·3 revolutions per minute. Pressure of steam, 14·7 pounds per square inch, above the atmosphere. Vacuum average 24·5 inches: consumption of anthracite coal, average 267 pounds per hour: natural draft. The propeller being fractions of a true screw, and supposing it to have had no slip, would have propelled the vessel at the rate of 680·775 feet per minute, or 6·67 knots per hour; but the vessel actually logged but 6 knots, showing a loss of nearly 11 per cent. by slip. This I consider was her maximum performance while I had charge of her.

Her minimum was her perfect inability to make steerage way against a double reefed topsail breeze, in an effort to make a harbor in the Chesapeake bay, during the same season, although there was a pressure of 40 pounds to the square inch, and making 32 to 33 revolutions. She was supplied with Ericsson's surface condenser and fresh water apparatus, to supply the boilers, which gave her all the advantages of economy and efficiency to be derived from that source: notwithstanding this pressure of steam, with the advantages of a good vacuum, I believe she would have fell off, had it not been for the very great velocity of the current of water that was driven past the rudder by the action of the propeller, which at once shows the great advantage in the steering of a vessel with a propeller, over that of the side wheel.

This event, then as now, convinces me, that with the screw propeller equal speed cannot be obtained with that of paddle wheels, even with equal amounts of fuel, other things being equal, as was suggested in the April number of the Journal.

This may be, and was, one of those extreme cases; but always when running head to wind or sea, when the progress of the ship was much retarded, there was no sensible diminution in the revolution of the engine, and hence none in the consumption of fuel.

I had ample opportunity to observe the same facts, while I was attached to the Princeton, but probably not to so great an extent. I do not wish to be understood by this, as opposing the adoption of screw propellers as a mode of propulsion, but to the contrary: yet I would have them adopted without taking from the paddle-wheel, any portion of their well earned merit and efficiency, for I doubt very much whether there can be found any one in this age of the propeller, who would hazard his reputation on propelling a ship of the *Pacific's tonnage* across the Atlantic in 9 days and 20 hours, under such circumstances as to produce the greatest benefit to the builders or company. There is no one who would doubt for a moment, that if the Legaré had been a side-wheel steamer, with equal amounts of power developed under the same circumstances, but that she would have gone into the harbor, or her consumption of fuel reduced, instead of having to fall off, and take a course opposite to her destination, in order to avail herself of the prevailing wind. Had it been necessary for her to have laid to, then one of the great advantages of the screw propeller would have been manifest, viz: the perfect ease with which the ship could have been managed. I have been in the Princeton when lying to in a gale of wind, with the propeller making from 4 to 5 turns per minute, and the effect was astonishing; the rudder being placed in a position to counteract the effect of the storm sails, and the propeller making just turns enough to cause a current by the rudder, by which means she would never make but little, if any leeway, an advantage that her officers understood and appreciated. Again, should it be necessary to suspend the operation of the propeller, it can be done in a few moments; so also can it be put in operation with as much despatch. But not so with the paddle wheels, requiring as they do, from 2 to 4 hours to prepare them for sailing to the best advantage, and as many more to refit them for steaming, to say nothing of the danger attending the operation. The paddle wheel has, however, all the advantages of speed and economy where equal tonnage is used. In regard to paddle wheel steamers, there is no doubt but that for all increase of resistance a decrease of revolution, and necessarily a diminution in the consumption of fuel, ensues. The Mississippi, of 12 furnaces, when by a heavy head wind or sea, her speed became less, the number of furnaces in operation was reduced to 8, or the fires were banked. Observation has gone far to prove one of two things, viz: that there is no decided advantage in using sail, with a side wheel steamer, unless the wind is perfectly fair, or if the wind is abeam, there is no economy in steaming with the sails set, further than to overcome the resistance of the wheels, which is rather expensive sailing. In either case, if she were a propeller, the sails could be used with good effect, showing their great advantage in this respect. Hence I conclude, that for duties where speed and regularity are essential, the paddle wheel has the advantage pre-eminently; while the advantages of the propeller consist in its allowing the sails to be used, and full broadsides with advantage, on vessels of war, without the usual interruption of wheel-houses, &c. Its ready adaptation as an auxiliary to sailing vessels and freight vessels of moderate capacity. S.

For the Journal of the Frankinl Institute.

A Series of Lectures on the Telegraph, delivered before the Franklin Institute. Session, 1850–51. *By* Dr. L. Turnbull.

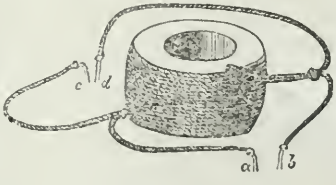
Continued from page 407.

Magneto-Electricity.—The power which electricity of tension possesses of causing an opposite electrical state in its vicinity, has been expressed by the general term induction, which, as it has been received into scientific language, may also, with propriety, be used in the same general sense to express the power which electrical currents may possess of inducing any particular state upon matter in their immediate neighborhood, otherwise indifferent; this is the meaning given to it by Professor Faraday, in his *Experimental Researches.* Previous to the experiments of this distinguished philosopher, certain results of importance had been obtained by Ampère, showing the induction of electrical currents by his experiment of bringing a copper disc near to a flat spiral; also his repetition of Arago's experiment, and the wonderful effects produced by Sturgeon Moll and Henry. Still, Faraday remarks, it appeared unlikely that these could be all the effects which induction by currents could produce.

These considerations, with their consequences, stimulated him to investigate experimentally, with the hope of obtaining electricity from ordinary magnetism.

Though baffled in his early attempts, he at last succeeded in laying open a new branch of electro-dynamics, which vies in interest and importance with the fundamental discovery of Œrsted. "A copper wire 203 feet long, was passed in the form of a helix, around a large block of wood, and an equal length of a similar wire was wound on the same block, and in the same direction, so that the coils of each helix should be interposed, but without metallic contact, between the coils of the other. The two ends of one of the helices, *a* and *b*, as in Fig. 16, were connected with a galvanometer, and those of the other, at *c* and *d*, with a strong galvanic battery, with a view of ascertaining whether the passage of an electric current through one helix, would create or induce a current in the adjoining helix. It was found that the galvanometer needle indicated a current to have been elicited in the under wire, at the moment of completing and breaking the circuit but that, in the interval, no deflexion took place. And likewise, the induced currents readily magnetized a sewing needle, while the electric current along the inducing coil was in

Fig. 16

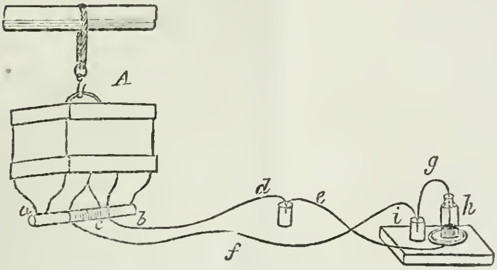


the act of beginning or ceasing to flow, but at no other period. An electric current transmitted from a galvanic battery through a conducting coil, does not induce a current in an adjoining coil, except at the moment of making or breaking the circuit. When the circuit is closed, the direction of the induced current is opposite to that of the inducing one, but when it is broken, the direction of both is the same." To this phenomenon, Professor Faraday gave the name of volta electric induction. The power of magnetism, to induce or create an electric current in an adjoining body, is greater than that of electricity itself. One of the most convenient of Professor Faraday's arrangements to represent this action, consisted of a hollow cylinder of pasteboard, around which two compound coils were adjusted. On connecting one of these coils with a galvanic battery, the other coil moved the needle of the galvanometer, and magnetized steel needles, as in the experiment just described. But when a cylinder of soft iron was introduced into the pasteboard case, and a galvanic current transmitted as before, the effect on the galvanometer was much greater. This effect results from the induction of magnetism in the bar of iron, which magnetism causes the increased amount of electricity in the coil connected with the galvanometer. To the phenomena in the last experiment, Professor Faraday gave the name of magneto-electricity. With such an instrument, he caused convulsions in the leg of a frog, and when the ends of the induced wire were armed with charcoal points, sparks of electric-light were obtained at the moment the galvanic circuit was broken, and closed through the inducing wire. When a permanent magnet is placed in a coil of wire, a current of electricity is set up in the wire. While the magnet remains in the coil at rest, no action is perceptible; but on removing it, another current is perceived. The currents move in opposite directions. These singular phenomena, which establish such new and intimate relations between galvanic and magnetic action, and supply additional evidence in favor of Ampère's beautiful theory of magnetism, have led to an experiment, by which, at first view, an electric spark appeared to be derived from the magnet itself.—*Faraday's Researches, Nov.* 1831.

Ampère's theory was, that all magnetic properties of bodies can be referred to currents of electricity circulating around each particle of those bodies.

After Professor Faraday had announced his experiment of obtaining sparks from the induced wire, other attempts were made to effect the same object with a magnet, without the aid of galvanism. The first person who succeeded in Great Britain, was Professor Forbes, of Edinburgh, who operated with a loadstone, which had been presented to the University of Edinburgh by Dr. Hope. A helix of copper wire was formed around the middle of a cylinder of soft iron, which was of such length that its extremities reached from one pole of the loadstone to the other. On applying and withdrawing the soft iron cylinder to and from the poles of the loadstone, magnetism was alternately created and destroyed within it. At these periods of transition, electric currents were induced in the helix surrounding the soft iron; and when, at these instants, metallic contact between the conducting wires of the helix was broken, an electric spark was visible. The arrangement of the apparatus is shown in Fig. 17, A is the magnet, *a b* a cylindrical collector of soft iron passing through the axis of the helix *c*, and connecting the poles of the magnet. The one termination *d e* of the wire passed into the bottom of a glass tube *h*, half filled with mercury, in which the wire terminated. The other extremity *f*, of the helical wire, communicated by means of the cup of mercury *i* with the iron wire *g*, the fine point of which may be brought by the hand into contact with the surface of the mercury in *h*, and separated from it at the instant when the contact of the connector *a b* with the poles of the magnet is effected. The spark is produced in the tube *h*.

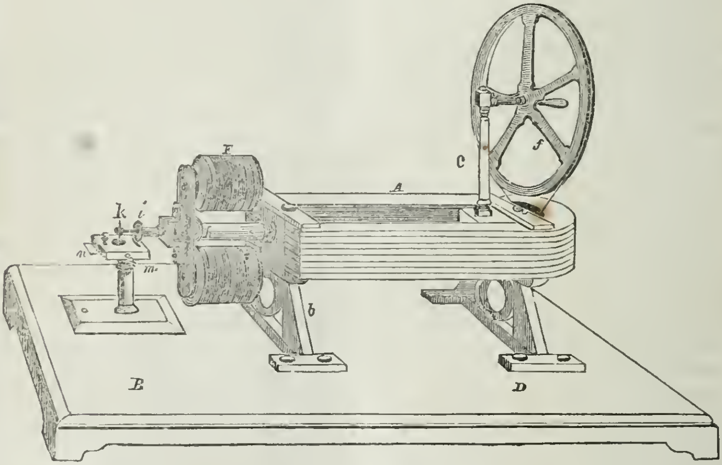
Fig. 17.



In this experiment, therefore, the electricity was obtained from the helix, and was induced in it by the soft iron, while in the act of acquiring or losing magnetism. (*Phil. Trans. of Ed.*, 1832.) The same experiment was performed by Professor Faraday, with a loadstone belonging to Professor Daniel; and shortly before the experiment of Mr. Forbes, Nobili and Antinori succeeded with an ordinary steel magnet. M. Pixii, of Paris, performed this experiment in 1832, with great effect. He caused a strong horse-shoe magnet to revolve horizontally upon an axis, so that its poles should pass in rapid succession, in front of a soft iron armature or keeper of the same form. (*An. de Ch. et de Ph.*) Mr. Saxton, a native of Philadelphia, but at that time residing in London, made an important improvement upon the apparatus of Pixii.

At the meeting of the British Association, at Cambridge, in June, 1833, Mr. Saxton exhibited his improvement, which consists in making he keeper the lighter body revolve, while the magnets remain at rest; and, secondly, the interruptions, instead of being produced by the revolution of points, were made by bringing one of the ends of the wire over a cup of mercury, and depending on the jerks given to the instrument by its rotation for making and breaking the contact with the mercury. Fig. 18 represents the complete machine. A is a compound horse-shoe magnet, composed of six or more bars, and supported on the rests, *b*, *e*, which are screwed firmly on the board, B D, into the rest; *e* is screwed on the brass piller *c*, carrying the large wheel *f*, having a groove in its circumference, and a handle by which it can readily be revolved on its axis; a spindle passes from one end of the magnet to the other between the pole, and projects beyond them about three inches, where it terminates in a screw at *h*, to which the armatures, to be described immediately, are attached; at the further extremity is a small pulley, over which a catgut band passes, by means of which, and the multiplying wheel *f*, the armatures can be revolved with great velocity. The armatures as seen at F, are nothing more than electro-magnets; two pieces of round iron are attached to a cross piece, into the centre of which the spindle *h* screws; round each of these bars is wound in a continuous circuit a quantity of insulated copper wire, one end being soldered to the round disc, *i*, the other connected with the copper wire passing through, but insulated from it by an ivory ring. By means of the wheel and spindle, each pole of the armature is brought in rapid succession opposite each pole of the magnet, and that as near as possible, without absolutely touching. The two armatures differ from one another. The one termed the quantity-armature is constructed of stout iron, and covered with thick insulated wire. The other, the intensity-armature, is constructed of slighter iron, and covered with from 1000 to 2000 yards, according to the size of the instrument, of fine insulated wire.—(*Lond. & Ed. Phil. Mag. Vol.* IX, *page* 360.)

Fig. 18.



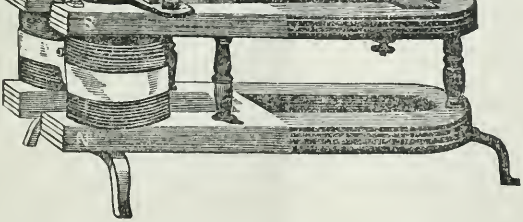
The quantity-armature is for exhibiting the magnetic spark, inducing magnetism in soft iron.

The intensity-armature, is employed for medical purposes, and for effecting chemical decomposition. This arrangement of armatures was an improvement by Wm. Clark of London, and was based upon the discoveries of Prof. Henry of this country, who found that an electrical current of quantity would induce a current of intensity, and on the other hand, that a current of intensity would make sensible a current of quantity.

According to Faraday, in the wire of the helix of magneto-electric machines, (as, for instance, in Mr. Saxton's beautiful arrangement,) an important influence of the principles of these actions of induced currents, is evidently shown. From the construction of the apparatus, the current is permitted to move in a complete metallic circuit of great length, during the first instants of its formation: it gradually rises in strength, and is then suddenly stopped by the breaking of the metallic circuit; and thus great intensity is given by induction to the electricity, which at that *moment* passes. This intensity is not only shown by the brilliancy of the spark and the strength of the shock, but also by the necessity which has been experienced of well insulating the convolutions of the helix, in which the current is formed; and it gives to the current a force at these moments very far above that which the apparatus could produce, if the principle of the inductive action of a current were not called into play.—(*Experimental Researches*, *Dec.* 8, 1834, *vol.* I, *page* 343.)

Another important improvement, or modification of the magneto-electrical machine, was made in 1838, by Prof. Page, of the U. S. Patent Office, According to Dr. Page's plan, two straight keepers, surrounded by coils of insulated copper wire, revolve between two powerful horse-shoe magnets, though much shorter keepers are used now than those he introduced. The steel magnets are fixed, with the south pole of one above the north pole of the other, at such a distance as just to allow the armatures to pass between them. The keepers are mounted on each side of a vertical shaft, in such a manner, that both keepers shall be passing between the opposite poles at the same time. They revolve in a horizontal direction around this shaft, while those before in use, revolved vertically around a horizontal axis. A little instrument, called a pole changer, was invented by Dr. Page, of Washington. It is composed of two semi-cylindrical pieces of silver, fixed on the axis upon which the keeper revolves, but insulated from that axis, and from each other. To each of the segments is soldered one end of the wire composing the coil. Two silver springs press upon these segments, and convey the electricity to the screw cups or point desired, by means of wires attached to them. The pole changer on the shaft, conveys the alternating currents in a constant direction to the screw cups, with which some metallic handles can be put in connexion for the purpose of giving shocks, &c. His improved form of the machine is represented in Fig. 19, made by Mr. D. Davis, Jr., of Boston, for Prof. Franklin Bache, of this city.

Fig. 19.



"Respecting the efficacy of this machine, the following is the substance of a statement in a letter from Dr. W. F. Channing, of Boston, to Prof. Hare, of this city. The unmitigated shocks from this machine are insupportable. When the wires which break the shocks are removed, the current becomes sufficiently uniform to be competent for electrolysis, or imparting magnetism to iron, included in a long helix of fine wire, comprised in the circuit of the helices of the machine. When sent through a circuit of a mile, the current from this machine was found abundantly competent to work the telegraph of Prof. Morse."—(*Hare on Electro-Magnetism*, p. 131.)

In Liebig's Annual report, (Vol. III, part 1, page 146,) it is stated that considerable improvements have recently been made in the magneto-electric machine.

Sinstedem, (Pogg. Ann, LXXVI, 29, 195, 524,) and Stöhrer, (Ibid, LXXVII, 467,) have published instructive suggestions for rendering them more perfect. Stöhrer has employed these machines, as it appears, with a satisfactory result, for the purposes of the electric telegraph. (Ibid, 485.) Dujardin, of France, has also used this instrument before the Committee on Electric Telegraphs, appointed by the legislative assembly: the circuit he employed being 140 leagues, by uniting two telegraphic wires at Paris and Lille, and employing a single magneto-electro machine, he caused his telegraphic machine to work with complete success, transmitting and printing under the eyes of the committee eighty-two letters a minute.—*Bulletin de la Société d'Encouragement de l'Industrie Nationale, May,* 1850, *p.* 221.

Many observers who have availed themselves of the magnetic-electro apparatus for the production of electric currents, have observed that the excitation of the current does not keep pace, as might have been supposed, with the velocity of rotation. In numerous cases, indeed, a maximum of the current-force has been observed to attend a certain velocity of rotation. This deportment has been explained by assuming that the production and disappearance of the magnetism in the iron cores requires a certain time. This explanation has, however, been proved by Lenz (*Petersb. Acad. Bull.* VII, 257.) to be sufficient for those cases only, in which the induction-currents set up are of a very low intensity, when, for instance, they have to pass through a great length of wire in addition to the coils in which they are developed. On the other hand, in the case of currents, which have only to surmount comparatively slight external resistances, their force increases, for equal velocity of rotation the more slowly, and, as this velocity increases, attains a maximum the sooner, the smaller the external resistance.

Lenz accounts for this phenomenon by the reaction of the induced currents upon the iron cores, by which magnetism is reproduced in the latter; the maximum of this magnetism coincides with the maximum of the current-force; not, however, for that very reason, coinciding with the maximum of the primary magnetism of the iron cores induced by the magnet, it consequently causes a deviation of those points of the rotation in which the induced current-force is at zero, or a maximum. The amount of deviation increases with the force of the current, and consequently with the velocity of rotation. It is therefore clear, why, in the commutators of the machine, which are empirically adjusted for the developement of the greatest current-force, (always in the same direction,) the change does not take place at the moment when the iron cores are opposite to the poles of the magnet; if the matter be only superficially examined; this is the instant at which the iron cores might be supposed to have attained the greatest possible degree of magnetism, and at which the induction in the copper wires would be at zero.—*Liebig's Ann. Rep. Chemistry*, 1848, *p.* 246.

ELECTRO-MAGNETIC TELEGRAPHS.

When Œrsted's splendid discovery was announced, and it was seen that feeble electric currents would produce a variety of magnetic actions, electrical telegraphing received a new impulse, and numerous forms of telegraphic apparatus were proposed, of which I will now endeavor to give an account, describing each step in the progress of discovery, and commencing with

Amperè's Telegraph.

In 1820, Amperè, in consequence of a suggestion of La Place, was led to devise the first telegraph, employing the deflexion of the magnetic needle, by the agency of the galvanic fluid, which, however, it appears that he did not carry out practically. His plan was tō have as many magnetic needles as there are letters of the alphabet, which might be put in action by the passage of currents through metallic conductors, made to communicate successively with the battery, by means of keys, which could be pressed down at pleasure, and might give place to a telegraphic correspondence that would surmount all distance, and be as prompt as writing speech to transmit thought.—*Ann. de Chem. et de Phys.* xv. 73.

The second telegraph was suggested by Peter Barlow, F. R. S., in 1825, that an instantaneous telegraph might be established by means of conducting wires and compasses.—*Edinburg Philos. Jour. Vol.* XII. *p.* 105.

In 1828, Victor Triboaillet de Saint Amand proposed to establish a telegraphic line from Paris to Brussels, by a metallic wire, about a line or a line and a half in diameter. He recommended to cover the wire with shellac, upon which was to be wound silk, very dry, which should be covered with a coating of resin. The whole was then to be put into glass tubes, carefully luted up with a resinous sustance, and secured by a last envelope, then varnished over and hermetically sealed; then, by means of a powerful galvanic battery, he would communicate the electricity to the conducting wire, which would transmit the current to the opposite station, to an electroscope, destined to render sensible the slightest influence, and left to each one to adopt at pleasure, the number of motions to express the words or letters which they might need.—*Report of Academy of Industry, Paris, from Vail's E. M. Telegraph*, *p.* 138.

Fechner's Telegraph.

Fechner, of Leipsic, in 1829, in his hand book of galvanism, remarks, that there is no doubt that if the insulated wires of twenty-four multipliers, corresponding to the several letters of the alphabet, and situated at Leipsic, were conducted under ground to Dresden, at which place the battery were situated, we could thus obtain a means, probably not very expensive, comparatively speaking, of transmitting intelligence from one place to the other, by means of signals properly agreed on before hand.

I confess it is a very seductive idea, to imagine that by future development of a system of such connexions at some time, a communication between the central point and the parts of a country can be established, which shall consume no time like communication between the central point of our organism and its members, by means of the nerves by what appears to me a very analogous arrangement.—*Lehrbuck des Galvanismus, p.* 269.

"Dr. Ritchie, in a lecture at the Royal Institution, London, in 1830, endeavored to illustrate the suggestion of Amperè, and exhibited a model of a telegraph constructed after his description; the arrangement was, however, very complex from the number of wires employed, &c., and Dr. Ritchie was not sanguine as to the ultimate practicability of the scheme."—*Journal of the Royal Institution, p.* 183.

Schilling's Telegraph.

In 1832 and 3, Baron Schilling, of Caunstadte, a Russian Counsellor of State, had occupied himself with an electro-magnetic telegraph. The Baron, who was attached to the Russian embassy, at Munich, at the time when Sömmering was engaged with his galvanic telegraph, already described, was much interested in the experiments of the latter, and shortly after Œrsted's discovery of the deflexion of the magnetic needle, Schilling was led to devise a needle telegraph, which consisted in a certain number of platinum wires, insulated, and united in a cord of silk, which put in action, by the aid of a species of key, 36 magnetic needles, each of which were placed vertically in the centre of a multiplier. Schilling was the first who adapted to this kind of apparatus, an ingenious mechanism, suitable for sounding an alarm, which when the needle turned at the beginning of the correspondence, was set in play by the fall of a little ball of lead. An improved form of his instrument was exhibited at the Bonn meeting of naturalists, by Dr. Munke, in 1835, (*Isis. Nog*. 1836,) and is described in detail, in Gehler's Physikalisches Wörterbuch, 1838, vol. IX, iii. In this improved instrument, light discs of card board, attached to magnetic needles enclosed in galvanometer coils, are moved by the galvanic or magneto-electric current. Five similarly prepared magnets, arranged so that the round disks of card-board were only seen edgeways, were connected by wires with the distant source of electricity; according to the direction in which the current was sent, the magnet was deflected to the right or left, in the one case showing to the observer, the one side, in the other case, the reverse of the card-board disc; thus ten separate signals were obtained, which by reference to a telegraphic dictionary, gave any required number of signals."

"Professor Henry, Secretary of the Smithsonian Institution, Washington, says, that in 1832, nothing remained to be discovered in order `to reduce the proposition of the electro-magnetic telegraph to practice. I had shown that the attraction of an armature, could be produced at any distance, and had designed the kind of a battery and coil around the magnet to be used for this purpose. I had also pointed out the fact of the applicability of my experiments to the electro-magnetic telegraph. I make a distinction between the terms discovery and invention. The first relates to the development of new facts; the second to the application of these or other facts to practical purposes."—*House Case, p.* 93.

To be Continued.

For the Journal of the Franklin Institute.

Prices of Cast Iron Pipes for Street Use.

The prices of cast iron pipes for street use, has become so much reduced in consequence of the low price of iron and improved method of manufacture, that a comparison between the prices of this year and those paid in 1820, may be interesting.

	Prices in 1820.	Prices in 1850.
22 inch pipe, per foot	$6 25	
20 " " "	5 00	$2 75
16 " " "	3 33⅓	2 18
10 " " "	2 40	1 03
8 " " "	1 66⅔	82
6 " " "	1 10	62
4 " " "	64	40
3 " " "	45	26

On Œrsted's Experiments on Falling Bodies. By PROF. J. R. YOUNG.†

"One of the most important observations first made by Œrsted, and since then confirmed by others, was, that a body falling from a height, not only fell a little to the east of the true perpendicular—which is, no doubt, due to the earth's motion—but that it fell to the *south* of that line; the cause of this is at present unexplained. It is, no doubt, connected with some great phenomena of gravitation which yet remains to be discovered."*—*Lit. Gaz., March* 22, 1851, *p.* 221.

The explanation of this phenomenon is very easy. Suppose a heavy body to be let fall from a point vertically over P (see diagram, p. 373:) when it is let go, the body will have a progressive velocity towards the east *greater* than the velocity of P at the foot of the vertical; and this velocity it will preserve throughout its fall, which, from the nature of gravity, must be in *a vertical plane* through P and C, the centre of the earth. Now the point P, at the foot of the vertical line, *recedes* from this plane towards the *north* during the descent of the body, since it describes a circle oblique to it round the axis of the cone: the body, therefore, will fall towards the *south* of the P as well as towards the east. If the experiment be performed in south latitude, the deviation will, of course, be *north* instead of south.

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† London Mechanics' Magazine, No. 1417.

* I regret that, from the loss of my library, I cannot now refer to the *Mecanique Celeste*; but I well remember that Laplace somewhere enters into a mathematical discussion of the phenomena: it is either in the first or second volume.

Remarks on Screw Propelling. By W. Gordon, *Lieut. R. N.*[*]

Sir,—It appears to be a general, and, in my opinion, an erroneous doctrine, that the most favorable results in *screw propelling* are to be obtained from small angles, or low pitches—in the form of the propeller. I have always maintained that there can be no loss of power, whatever may be the angle, (within certain limits,) but that a greater angle than that which is usually given will produce the *same* velocity in fine weather, with *fewer* revolutions of the screw; and whilst steaming against adverse winds, will be found still more conducive to the realization of *propelling* power, with the smallest expenditure of *engine* power.

These views have already been amply supported by the cases of the *Great Britain* and *Princeton;* but the publication in your 1442d. No., of experiments in the *Dwarf,* with screws of various angles, and the same diameter, has afforded the most convincing proof possible of the truth of what I have advanced. Unfortunately, most experiments in screw-propelling are referred to the vicious standard of *apparent* slip—a method which can only perpetuate error; but in the *Dwarf* experiments the *actual horse-powers exerted* are likewise given, by which means correct conclusions can be arrived at.

1. With an angle of 24°.12′, a speed of 9·11 knots was obtained with an expenditure of 168·8 horse power.

2. When the angle was increased to 30°.6′, with a screw of similar diameter and area, a speed of 9·05 knots was obtained with an expendture of only 154 horse-power, and a reduction in the revolutions of the screw, of more than ($\frac{1}{5}$) *one-fifth.*

There can be no stronger proof than these experiments of the superiority of the long pitch; but the *apparent* slip is stated in the first case to be only 30·4 per cent., whilst with a much smaller power, producing the same velocity, it was 36·3 per cent. Any theory, therefore, which is founded on the apparent slip of a screw must be false, and of no practical use. I could comment upon experiments with the screw of different areas, which are likewise connected with the preceding experiments.

London, April 9, 1851.

Translated for the Journal of the Franklin Institute.

Analogy between Light and Heat.

There are few subjects of physical science which present at present greater theoretical interest, than the experimental demonstration of the perfect analogy which exists between the phenomena of light and of heat. Thus, by various experimenters, the phenomena of reflexion, refraction, dispersion, interference, double refraction, and polarization, have been demonstrated in each of these agents. In a memoir published in the *Annales de Chimié et de Physique, Novembre,* 1850, *p.* 267, Mm. de la Provostaye and Desains, have shown by a very interesting series of experiments there recorded, that the oil of turpentine and solution of sugar, which exercise the power of rotating the plane of polarization of light, exert the same influence over heat, and produce a rotation in the same direction, and of the same amount.

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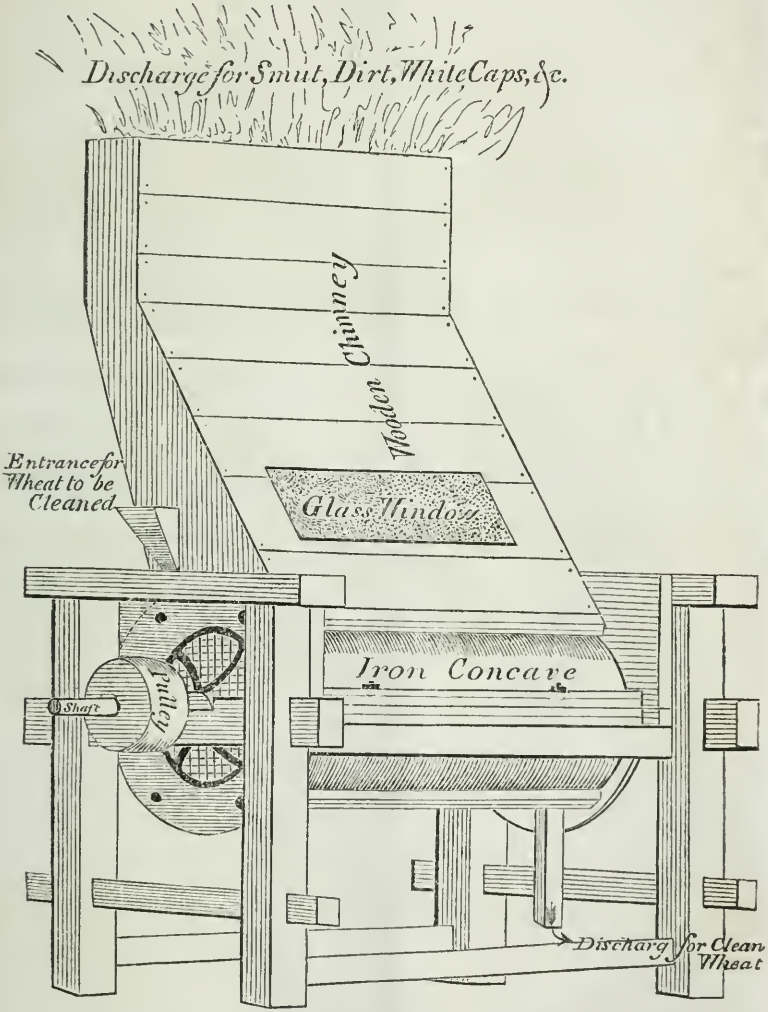
[*] London Mechanics' Magazine, No. 1447.

Description of an Improved Smut Machine. Invented and Patented by JEHU HOLLINGSWORTH, *Zanesville, Ohio, April 22d,* 1851.*

Figure 1 is a front view of the machine, when adjusted in its stand or frame.

Fig. 1.


Discharge for Smut, Dirt, White Caps, &c.
Wooden Chimney
Entrance for Wheat to be Cleaned
Glass Window
Iron Concave
Shaft
Pulley
Discharg for Clean Wheat

It consists of a horizontal concave made of cast iron. An iron shaft passes through this concave, to which is fitted a number of beaters; there is a pulley on one end of this shaft, by which it and the beaters are made to revolve 350 to 450 times per minute, according to the amount of wheat to be cleaned, the size of the machine, &c.

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* See Journ. Frank. Ins., vol. xxi, 3d series, p. 382.

The hopper through which the grain enters the machine, also the discharging spout at the other end, are both seen in this figure. The iron concave is open at both ends so as to admit *air freely;* it is also *open along the top*—this aperture being about *one foot wide*, *and extending from one end of the concave to the other.* Around this opening is closely fitted *a wooden chimney*, which becomes smaller as it ascends; this chimney is open at its top; there is a *glass window in it*, to show the action of the wheat, when the machine is in operation. When the beaters are revolving, the wheat is scoured round the concave until it reaches the *opening at the top*, where by centrifugal force it is driven up the chimney, until, overcome by its gravity, it falls back into the concave, to be scoured again; whilst the smut, dirt scoured off, the white caps or chaff, &c., *being lighter*, are forced, *at the instant they are disengaged*, up and out of the chimney, by *a blast* generated by the action of the beaters. This cleaning process is repeated at each revolution till the grain reaches the discharging spout.

The wheat can be *scoured more or less*, as desired, by means of a number of *aprons in the back of the chimney*, which are explained particularly in Figure 2.

Figure 2 represents a vertical section, or end view, of the concave, flanches and beaters, wooden chimney, *partition in it, and aprons.*

The cast iron concave extends from A round to B; between these two points *it is open;* the *front of the wooden chimney* commences at B and ascends to F, the *back of the chimney* commences at A and ascends to E. In this chimney, between the points A and B, is seen *an end view of a triangular partition*, which extends from one end of the chimney to the other, dividing the chimney *lengthwise* into two parts. In the space between the *back of the chimney and this triangular partition*, is a number of *movable aprons*, each of them so fixed on a wire (one end of which rests on the top of the partition, the other passing through the back of the chimney, and *ending in a crank*), that by turning these *wire cranks* (to which the aprons inside the chimney are fastened), any desired inclination can be given to them.

Starting at the hopper, where the grain enters, *following the arrows*, the wheat is scoured round the concave until it reaches the point B; here, there being *no concave to confine it*, it is driven (at right angles to the face of the beaters) *up between the partition and the front of the chimney;* the smut, dirt, chaff, or white caps, &c., pass up and out of the top of the chimney with the blast; *the wheat, freed of its impurities*, and *being heavier*, falls down *the back of the chimney* on to the above described *movable aprons*, which conduct it again into the concave; by moving these aprons in one direction it is *carried back, and retained longer* in the concave, and by this *means scoured over and over again;* or by moving these aprons in the *opposite direction*, it is hurried rapidly through the machine, so that a *forward* or *backward* inclination given to these aprons, will effect a little or a *great deal of scouring;* in this respect they are *complete regulators*, governing the scouring of wheat in the most effective manner.

For millers who require an *extraordinary amount of scouring*, there are connected with this machine *four rubbers*, which can be fastened to the

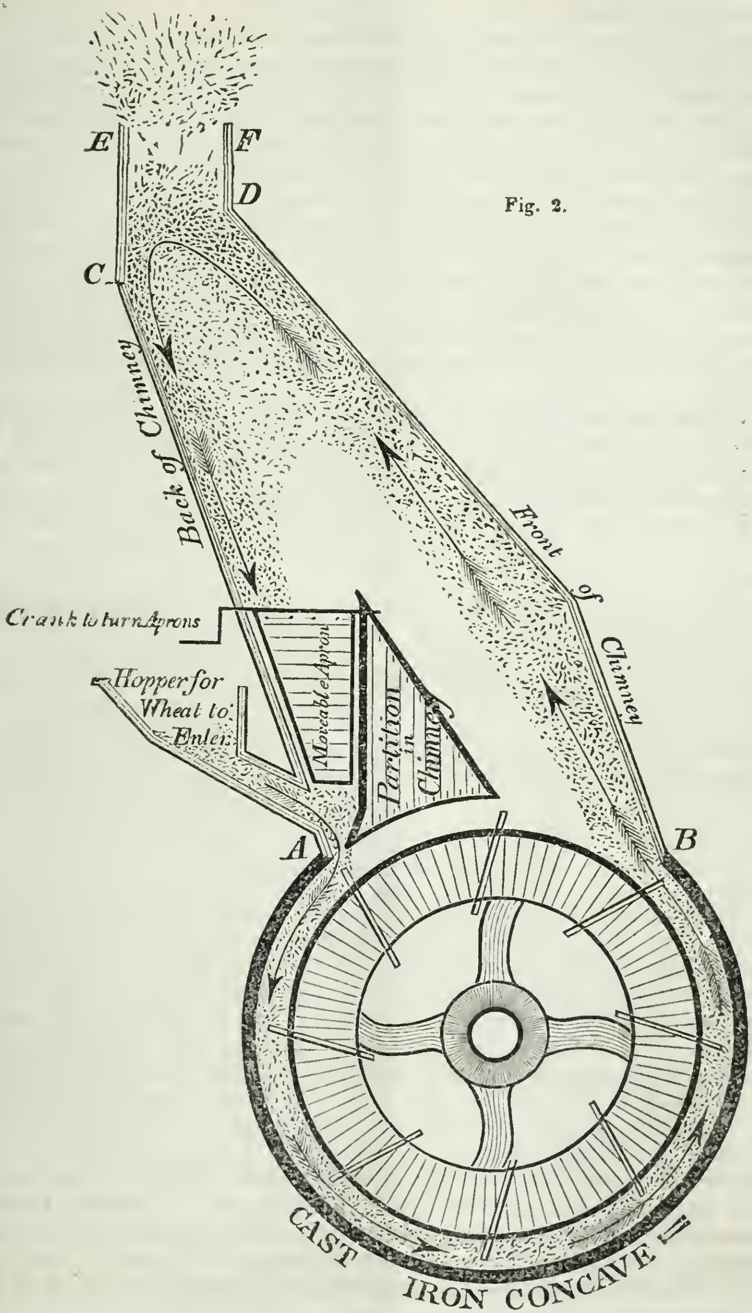
E
F
D
C
Back of Chimney
Front of Chimney
Crank to turn Aprons
Hopper for Wheat to Enter
Moveable Apron
Partition in Chimney
A
B
CAST IRON CONCAVE

Fig. 2.

edges of the beaters in a few minutes, and so adjusted as to scour *very severely*. They can be used, or not, as may be desired.

This blast, which carries off the smut, white caps, and other impurities, is generated by the same action of the beaters that scours the wheat; the air for it is supplied at the open ends of the concave, and finds an ample and unobstructed vent out of the top of the chimney, so that this machine, by one and the same action of the beaters (without any increase of power), becomes a smut mill, scourer, and extensive fan.

Particular attention is desired to this fact, that the blast carries out the smut and impurities the instant they are disengaged (which is the only proper time to be rid of them); it does not allow them to be conveyed through the body of the wheat (blackening the ends of the berries), but it is acting all the time, driving the impurities out of the chimney at each revolution, as fast as they are disengaged, by the scouring action of the beaters.

By this fan action of the machine, a current of air is always drawing into the open ends of the concave, carrying with it any dust floating in the surrounding atmosphere; hence, instead of being dirty, the contrary is the case; it cleans the room in which it runs.

In consequence of the peculiar action of this machine, throwing the wheat out of the concave at each revolution, it requires little power to drive it.

For country mills, no other cleaning apparatus is required, excepting a shaking or rolling screen, before the grain is put through this smut mill. For merchant mills, it is capable of doing the heaviest work in the most thorough manner: for its *safety against fire*, its durability, its efficacy as a thorough smut mill, scourer, and fan, see the following certificates.

These machines are manufactured by Beaumont & Hollingsworth, *Zanesville, Ohio*, who will promptly execute any orders that may be sent to them.*

Experiments on Charcoal.†

M. Violet, the government commissioner of gunpowder, has presented to the Institute the following observations, resulting from experiments to obtain a charcoal with a constant amount of carbon. He has experimented on seventy-five species of wood, native and foreign, but especially on the black alder (*bourdaine, resprun*), a sort of white timber nearly resembling prickwood (*fusain*), which is mostly used. If wood be carbonized, the quantity of carbon obtained is in an inverse ratio to the temperature to which it has been submitted by the process. Thus, at a temperature of 250° Reaumur, the amount of carbon is 50 per cent.; at 300° it is 33 per cent.; at 400° about $\frac{20}{100}$ per cent.; and at 1500°—the highest temperature obtainable, being the melting point of platinum—the amount of carbon is but $\frac{15}{200}$. The quantity of carbon originally contained in wood is separated, in the process of carbonization, into two portions, of which one remains in the charcoal, while the other passes off with like volatile substances. This separation varies according to the temperature employed in the act of carbonisation: at 250° the carbon remaining in the charcoal is double that which has escaped; between 300° and 350° both portions are equal. Not even the highest temperature, however, could change charcoal into pure carbon. Charcoal invariably contains gas even after being exposed to the highest temperature. At 250° the quantity of gas is half the amount of carbon; at 300° one-third; at 350° one-fourth; at 400° one-twentieth; at 1500° one-hundredth part. If wood is carbonized in perfectly closed vessels, it yields three times more charcoal than by the ordinary process. Treated in this way, wood undergoes a real process of fusion at a temperature of from 300° to 400°; it becomes semi-fluid, glutinous, and presents, when cooled, a black, lustrous mass, from which all organic texture has disappeared—resembling, in a word, coarse coal. This process is, after all, nothing but a repetition of that grand operation by which nature has produced those extensive strata of coal all over the globe. Charcoal obtained in close vessels contains ten times more cinders than that made in the ordinary way—a sure sign that the volatile substances of the wood carry with them a great quantity of mineral substances during the process of carbonization, although the latter be not volatile by themselves. *Proceed. Paris Academy.*

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* See advertisement on the cover of this Journal.

† London Architect, 1851.

Method of obtaining Oxygen from Atmospheric Air. By M. BOUSSINGAULT.*

Lavoisier resolved atmospheric air into its constituents by keeping a confined portion for twelve days in contact with mercury heated nearly to its boiling-point. Boussingault has attempted to use baryta for the purpose of extracting the oxygen from the atmospheric mixture in larger proportion. The method is simple; the air is conducted over pieces of baryta at a dark red heat until it has become converted into peroxide of barium; the oxygen is subsequently again expelled by the application of a more intense heat. The moisture and carbonic acid usually present in the air do not materially interfere with the process. The baryta, however, contained so much alumina and silica, that after repeated use it became caked, and hence no longer of any use. Pure baryta was free from this inconvenience. According to Boussingault, on the large scale, on using 10 kilogrammes of baryta, which absorb 730 litres of oxygen, and should again part with it, 600 litres is the quantity always obtained in practice. Hence with furnaces in which 100 kilogrammes of baryta distributed in 8 to 10 tubes can be heated at once, from 24,000 to 30,000 litres of oxygen may be produced in twenty-four hours.—*Comptes Rendus, vol.* XXXII, pp. 266, 267.

Translated for the Journal of the Franklin Institute.

Deep Sea Soundings.

M. Faye, at the meeting of the Academy of Sciences of Paris, 20th January, described an apparatus which he considered as new, and presenting valuable facilities for deep sea soundings, requiring no line, and giving with accuracy the perpendicular depth and the set of the submarine currents. It consists of a stout cylinder open below, and filled with a liquid sufficiently lighter than water, to cause the apparatus to float; it is sunk by having two cannon balls attached to it, which are released by a trigger striking against the bottom, when the apparatus returns to the surface. The distance and direction of its point of emvergence from that of its sinking, will give the resultant of the submarine currents; and it has, moreover, attached to it a light fan, whose revolutions will measure the space moved over. (This is Saxton's apparatus for measuring the velocity of curren's of water.) A little vessel attached and provided with valves to close when the vessel begins to rise, will bring to the top a specimen of the bottom water, and an overflow thermometer, (on Walferdin's principle); a modification of the apparatus itself will measure the temperature. At subsequent sessions of the academy, the proposed apparatus was shewn to be not new, but it remains to be seen whether it may not prove very useful.

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* London, Edinburgh, and Philosophical Magazine, June, 1851.

On some Properties peculiar to Caoutchouc, and their Applications. By Mr. Brockedon.*

Caoutchouc is a vegetable constituent, the produce of several trees. The most prolific in this substance are, *Siphonia caoutchouc Urceola elastica*, *Ficus elastica*, &c. Of these, the *Siphonia caoutchouc* extends over a vast district in Central America,—and the caoutchoc obtained from this tree is best adapted for manufactures. Over more than 10,000 square miles in Assam the *Ficus elastica* is abundant. The *Urcela elastica*, (which produces the Gintawan of the Malays) abounds in the islands of the Indian Archipelago. It is described as a creeper of growth so rapid, that in five years it extends 200 feet, and is from 20 to 30 inches in girth. This tree can, without being injured, yield by tapping from 50 to 60 lbs. of caoutchouc in one season. A curious contrast is exhibited in the tardy growth of the tree from which the gutta percha is obtained. This tree does not come to its prime in less than from 80 to 120 years. The produce cannot be obtained but by the sacrifice of the tree. It is found in a concrete state between the bark and the wood after the tree has been cut down; and it is in this condition that, having been scraped out, it is sent to our market. When coagulated by evaporation or agitation, caoutchouc separates from the aqueous portion of the sap of the trees which yield it. This solid and fluid cannot afterwards be re-united, any more than butter is capable of mixing with the milk from which it is separated. Caoutchouc is a hydro-carbon. This chemical character belongs to all varieties of the substance, and many other vegetable constituents, though they differ materially in physical qualities. Some specimens are harder than gutta percha itself, while others never solidify, but remain in the condition of birdlime or treacle. The process termed the *vulcanizing* of caoutchouc was discovered by Mr. Thomas Hancock in 1843. A sheet of cauotchouc immersed in melted sulphur, absorbs a portion of it, and at the same time it undergoes some important changes in many of its characteristic properties. It is no longer affected by climatic temperature:—it is neither hardened by cold, nor softened by any heat which would not destroy it. It ceases to be soluble in the solvents of common caoutchoc, while its elasticity becomes greatly augmented and permanent. The same effect may be produced by kneading sulphur into caoutchouc by means of powerful rollers; or the common solvents naphtha and spirit of turpentine may be charged with a sufficient amount of sulphur in solution to become a compound solvent of rubber. In these cases articles may be made in any required forms before heating for the change of condition. It is necessary, however, for this purpose, that the form should be carefully maintained during the exposure to the heat necessary to effect the vulcanization, which leaves it in a normal state. A vulcanized solid sphere of 2½ inches in diameter when forced between two rollers a quarter of an inch apart was found to maintain its form uninjured. In fact, it is the exclusive property of vulcanized caoutchouc to be able to retain any form impressed on it, and to return to that form on the removal of any disturbing force which has been brought to act on it. Caoutchouc slightly expands and contracts in different temperatures: it is also capable of being condensed under pressure. A cube of 2¼ inches, impactly secured, was subjected to a force of 200 tons. The result was, a compression amounting to one-tenth; great heat appeared to have been evolved; and the excessive elasticity of the substance caused a fly-wheel weighing 5 tons to recoil with an alarming violence. The evolution of heat from caoutchouc under condensation is a property possessed by it in common with air and the metals. It differs, however, from the latter in being able to exhibit cold by re-action. Mr. Brockedon stated that he had raised the temperature of an ounce of water two degrees in about fifteen minutes by collecting the heat evolved by the extension of caoutchouc thread. He refers this effect to the change in specific gravity. He contends, that this heat thus produced is not due to friction; because the same amount of friction is occasioned in the contraction as in the extension of the substance,—and the result of this contraction is to reduce the caotchouc thus acted on to its original temperature. Attention was directed to some of the latest applications of the elastic force of caoutchouc.—*Proceed. Roy. Inst. March* 21, 1851.

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* London Athenaeum, April, 1851.

Translated for the Journal of the Franklin Institute.

Reflexion of Light from the Surface of Liquids.

The following are the conclusions of M. Jamin, from a series of experiments recorded in the *Annals de Chimié et de Physique*, for February, 1851:—

1st, Liquids surfaces polarize light incompletely and elliptically.

2nd, Liquids having a high index of refraction have a positive anomaly, or difference of phase between the principal components of the reflected motion.

3rd, This anomaly becomes negative, when the index is very small.

4th, There are substances, whose indices are about 1·4, whose polarization is rectilineal.

5th, The laws of the intensities and anomalies are represented by the formulæ of M. Cauchy.

6th, If substances are superposed, the reflexion from their surface of separation follows the same *laws.*

7th, In this case it is impossible to predict the value and the sign of the coefficient of ellipticity.

The memoir, moreover, includes a table of the constants of reflexion for a number of liquids.

Translated for the Journal of the Franklin Institute.

Formation of Minerals in the Moist Way.

M. de Senarmont, to whom we owe the valuable and ingenious experiments upon the conducting power of crystallized substances, has been engaged in the endeavor to form some of our common minerals occurring in veins, by the liquid way—and has succeeded in getting from solutions containing carbonic acid and sulphuretted hydrogen, and the alkaline sulphurets and bicarbonates, either alone or together, microscopical but perfectly formed crystals of the following substances:

Native metals—Copper, silver, mixed without alloying, arsenic.

Oxides—Hematite, quartz, red oxide of copper.

Carbonates, of magnesia, iron, manganese, cobalt, nickel, zinc, copper, (Malachite.)

Sulphate of Baryta.

Sulphurets of arsenic (Realgar,) antimony, bismuth, iron (Pyrites,) manganes, cobalt, nickel, zinc (blende,) copper.

Oxysulphuret of antimony.

Arseniosulphurets of iron (Mispikel) silver.

Antimoniosulphuret of silver.

"What I proposed to myself was, to establish by experimental proofs, the opinion controverted, but to me very probable, which attributes the filling of concretionary veins to the thermal incrusting deposits, and to shew that the formation of a great number of the minerals which are there met with, whether crytallized or amorphous, does not always require conditions or agents very different from actual causes.—*Comptes Rendus de l'Academie des Sciences de Paris*, 24 *March*, 1851.

FRANKLIN INSTITUTE.

Proceedings of the Stated Monthly Meeting, June 19, 1851.

S. V. Merrick, President, in the chair.

John F. Frazer, Treasurer. } Present.
Isaac B. Garrigues, Recording Secretary. }

The minutes of the last meeting were read and approved.

Donations were received from The Royal Irish Academy, Dublin; The Royal Institution of Great Britain, London; The Governor of Minnesota; H. Haupt, Esq., Harrisburg; Elwood Morris, Esq., Chilicothe, Ohio; Pofessor S. S. Haldeman, Columbia, and Messrs. A. Hart, Professor John F. Frazer, and W. C. Grimes, Philadelphia.

The Periodicals received in exchange for the Journal of the Institute were laid on the table.

The Treasurer read his statement of receipts and payments for the month of May.

The Board of Managers and the Standing Committees reported their minutes.

New candidates for membership in the Institute (1) were proposed, and those proposed at the last meeting (4) were duly elected.

The Committee on the Cabinet of Minerals and Geological specimens reported, that the collections of the Institute were so far arranged as to admit of the room being thrown open for the use of the members.

Dr. Rand, Chairman of the Committee on Meetings, brought before the members a specimen of silvered glass, consisting of a cup manufactured by the New England Glass Company, being the first manufactured for sale in this country. It was of great beauty, resembling solid silver, and was much admired by the members present: the process was not known, but we suppose it to be Drayton's. The agents for the sale of the article are Messrs. Muzzey & Monroe, of this city.

Mr. Wm. Winter exhibited a new ventilating chimney cap, of galvanized iron, consisting of a square base and three circular pieces, pointed at the top and bottom, the lower angles overlapping the open spaces for the exit of the heated air. It has a concave top on three standards so as to prevent any downward draught. The great advantage claimed to be derived from the circular pieces, is the greater amount of expansion allowed for the heated air, and the prevention of side currents of cold air.

Mr. J. A. Maynard, of Boston, exhibited to the meeting his improved patent hot air and water tuyeres for blacksmiths' forges, and made the following remarks:

This tuyere consists of a hot air chamber, and water nozzle, placed within the forge on the side, which can be extended to a greater or less distance, as the work may require. The arch nozzle, so termed, is filled with water, supplied from a vessel placed behind the forge. The pipes which supply it are tapped into the nozzle, and extend through the hot air chamber and the back of the forge, one conducts the water in, and the other, when steam is generated, passes it out at the top of the vessel that contains the water; there are two pipes connected behind the hot air chamber, the top one conveys the air from the bellows into the hot air chamber; and from thence it is blown hot, through the water nozzle into the fire, the nozzle being filled with water is defended from the action of the fire. No clinker can adhere to the nozzle and the arch form prevents it running in to clogg, there being no surface for it to rest upon; the iron being set low in the forge, it gives a body of coal between the tuyere and the iron, which prevents the blast from coming directly on the iron to burn it; the blast is blown a little upwards, which is an advantage. A wide or crooked piece of iron can be wrought as advantageously as a small or straight one; there is no chance for the coal to be consumed except around the iron that is being heated. On the end of the lower pipe there is a valve through which the ashes pass, which is opened by the action of the bellows or gate when stopped, and being open it prevents all gas or heat from going back so as to burn the bellows; it also gives a draught into the fire to keep it alive.

Mr. G. W. Smith made some interesting remarks upon the lights on our coasts, which he had carefully examined during a recent trip to Charleston, in the steamer Albatross.

Mr. I. W. P. Lewis exhibited a beautiful model of the Sand Key light house, as well as drawings of various others. A full report of Mr. Lewis' observations with drawings will be published in a subsequent No. of the Journal.

The propeller and calculating machine of Mr. Nystrom, of which full accounts have been published in this Journal, were exhibited and explained by Prof. Frazer.

OBITUARY NOTICE.

For the Journal of the Franklin Institute.

Character of the late M. Bendant, the Mineralogist.

We take the following beautiful trait of character in a distinguished French scientific man, recently deceased, from *l'Institute*, where it is given as an extract from the funeral eulogy of M. Bendant, pronounced by M. Milne Edwards.

"After having filled with distinction the chair of Physics in the Lyceum of Marseilles, and acquired a high rank in France, by his numerous works of investigation, M. Bendant was designated by the Academy of Sciences, and by the college of France, to fill the place of Professor of Physics in this latter establishment. The ordinance of the King Louis XVIII., which conferred this title, was already signed by that monarch, when our modest colleague learns that his friend Amperé eagerly desired to have that position, and that it was necessary that he should have it, to allow him to employ himself with experiments, whose value he knew; perhaps he also thought that the scientific rights of Amperé were superior to his own; and obeying only the noble impulses of his heart, he went to the minister, and requested that the ordinance which had been issued in his favor, and was intended to appear in the Moniteur the next day, should be annulled; pleaded his friend's cause warmly, and not being able in this first interview to overcome the resolution which M. Corbiere (in whose department the College of France was at that time,) had taken, he perseveringly insisted for two weeks on obtaining the change which he solicited, as many others would have solicited a favor; and finally, to cut the question short, he made his resignation public through the press. This act of so rare a disinterestedness, opened to Amperé the laboratories of the College of France, where he in a short time made his beautiful discoveries in electro-magnetics, and Bendant, seeing his friend render such services to science felt himself happy to have been the primary cause of his success, and found in the glory of Amperé, the recompense of the sacrifice which he so generously imposed on himself.

JOURNAL

OF

THE FRANKLIN INSTITUTE

OF THE STATE OF PENNSYLVANIA

FOR THE

PROMOTION OF THE MECHANIC ARTS.

AUGUST, 1851.

CIVIL ENGINEERING.

For the Journal of the Franklin Institute.

On the Comparative Qualities of the Metal Employed in the Construction of Railroads. By Hu L. Damsel.

Continued from page 21.

Attempts have been made to remedy the tendency of best iron to laminate, but from not sufficiently attending to the minutiæ of the manufacture, they have been but partially successful. An ingenious apparatus for twisting the rail bar, whilst it is in course of manufacturing, has been patented in the States, and also in England. Through the medium of powerful machinery, the bar is twisted while in its rough state, until the fibres of metal encircle the rail instead of lying in a direction parallel with its axis. The metal thus prepared, appears to be much better adapted for certain manufacturing purposes than that produced in the usual way; but its superiority, as alleged, for railway bars, is not so apparent. Indeed, on attentive consideration, it will be manifest that the twisting of the bar alone, cannot retard the laminating process, for the fibrous character of the metal still exists, though it has been forced into a spiral instead of its previous parallel direction in the bar.

An English manufacturer has patented a process for manfacturing what appears to be a nearer approach to an anti-laminating rail. His plan is to construct the upper or wearing part of the rail, from puddled charcoal iron, in the unwrought state, and the lower or non-wearing part, from such iron as is ordinarily used in manufacturing rails. By this arrangement of the materials, the formation of fibre is materially reduced. Its existence, however, even in a reduced degree, must exercise a prejudicial effect on the durability of the rail bar. Yet, notwithstanding this circumstance, rails made under this patent have stood considerable rolling with fewer instances of lamination than might have been expected.

But the high price which is charged for these rails in England, where charcoal iron readily sells at prices nearly double those of ordinary coke pig iron, has hitherto limited their employment to a few isolated experiments on some of the leading railways in that country. Besides which, there does not appear to be any sufficient reason why charcoal iron should be necessary to the production of an anti-laminating rail. The high character which charcoal iron possesses for purity and tenacity, and its peculiar fitness for numerous minor manufactures, has led to its adoption as a standard of quality for iron, without sufficiently considering the various purposes to which this metal is applied, and the very different circumstances under which it is employed. Common brands from coke and coal fuel furnaces, have been used in the manner in which this charcoal iron has been used, and with similar success. They produced rails equally free from lamina, and with the important advantage of not increasing the cost of production.

Although the rails thus manufactured contained less than the usual quantity of fibre, the disadvantage of having masses of various sizes in the same pile, the injurious effects from which has already been made known, must not be overlooked. Lamination from this cause exceeds that from all others, whence the necessity for equalizing the sectional dimensions of the pieces composing the pile. The disproportion between the masses of metal composing the patent pile is very great, and their liability to laminate from this cause is therefore imminent.

To discover means whereby wrought rails might be rolled from common metal, and yet be free from the laminated structure attendant on its employment, experimental trials were made with rails rolled from variously constructed piles, built up of common puddled iron, with and without the admixture of superior qualities. This was done with the view of ascertaining if the present system of piling could not be advantageously altered for one which, with little or no additional expense in manufacturing over that now incurred, would result in the production of a perfectly non-laminating rail. The object aimed at, therefore, was one which, if attained, would be of incalculable benefit to railroad companies.

The plan usually adopted, is to arrange the bars, whether these are of mill or puddled iron, side by side, and one on the other, till a pile is built of the required dimensions. By thus arranging them, the grain or fibre of all the bars runs in the same direction—longitudinally. This parallelism is maintained in the subsequent process of rolling, when the pile is distended from its original length of about 3 feet into a finished rail of from 24 to 26 feet long, but is reduced laterally and vertically from 7 inches wide and 9 inches high, equal to 63 sectional inches to a bar, averaging, perhaps, 6 square inches. The fibres of metal are thus distended longitudinally to 9 times their original length, and to meet this elongation, they are compressed into one-ninth of their original sectional area. The fibrous character of the metal continues, and is multiplied at each successive rolling, until, as is not unfrequently the case at iron works, it is no longer available for manufacturing purposes.

The remedy which the writer designed for this prevailing tendency to laminate consequent on the disposition of the plates or bars in parallel layers, was to withdraw a few of the long bars which ran the whole length of the pile, and replace them with a number of short ones, which were laid cross-wise to the others, and were therefore in length equal to the breadth of the pile.

The first piles constructed on this plan were wholly composed of puddled iron disposed in parallel layers, with the exception of the two upper layers, which were of best metal. The top layer of best metal was of the usual length, and was placed along the pile in the usual manner, but the one under it resting on the puddled bars, was composed of short pieces laid across the pile, with their grain or fibre at right angles with that of the others.

Apparently, this simple alteration in the disposition of the bars of metal composing the unwrought pile, could not affect the structural arrangement of the manufactured bar, but in reality it occasioned a most important change. The rails rolled from these piles were placed on cast iron blocks, standing 3 feet apart, and broken by blows from a heavy ram falling freely between fixed guides. The appearances presented by the fractured ends were very different from anything previously observed in rails. For a depth of full half an inch from the surface, the fractured metal presented the crystalline appearance of fine white cast iron, while the remainder of the rail exhibited the usual coarse fibrous character commonly observed in rail iron. Yet, although the contrast between the two metals was striking in the extreme, the line of junction was indiscernible, and the union of the two qualities appeared to have been effected in the most solid manner.

The alteration thus effected in the structure of the metal by the single layer laid across the pile, led to further experiments on piles with two cross-laid layers, having a thickness of long bars between; and in subsequent experiments the number was increased till every alternate layer was thus disposed. The effect of a second cross layer of best iron was to double the depth of the fine crystalline metal, but when this second layer was of puddled iron, the metal, when broken, appeared to be formed of larger crystals not unlike coarse white pig iron. The metal in the bars rolled from piles built up with layers laid alternately along and across the pile, could scarcely be distinguished in its appearances from cast metal, so great had been the change which the altered mode of piling had effected in the structural arrangement of the iron.

By placing a cross layer of short bars at the head and foot of the pile, the rail when broken exhibited the crystalline structure at the top and bottom, with a centre mass of fibrous metal, and on placing cross layers in the middle of the pile only, the rail was found fibrous at both top and bottom, but crystalline in the middle. It is possible, therefore, to produce rails with non-fibrous metal in any desired proportion, and occupying any desired position.

The experiments on the conversion of fibrous into crystalline iron at pleasure, by merely altering the system of piling, satisfactorily demonstrated that, by disposing a moiety of the bars across, instead of along the pile, as was heretofore the universal practice, a rail perfectly devoid of lamina could be manufactured from highly fibrous metal. The additional expense from using the short cross bars over that incurred in the usual way, amounted to about ten cents per ton on the rails experimented upon; but in the event of the plan being generally adopted, as it is presumed it will be, there being no patent right to contend with, the additional expense from the extra labor in shearing, will probably not exceed three or four cents per ton.

These highly favorable results, exceeding as they did the most sanguine expectations of the writer, led to an inquiry respecting the origin and nature of fibre in wrought iron.

It is known to metallurgists that crude bar iron, as drawn from the puddling furnace, is devoid of any fibre; and that this property is developed only in the more advanced stages of the manufacture. If the bloom of puddled iron is worked under a hammer, fibre may be produced in any desired direction, or, the operation may be so conducted that the resultant mass shall possess no perceptible fibre; but metallic bars elongated by rolling will possess fibre in the direction of their length. The iron from the puddling rolls displays a few fibres, which are, in the subsequent processes of reheating and rolling, rapidly multiplied, as described in a previous paper, until the bar appears to be one mass of longitudinal fibres. These have been produced by the mechanical action of the rolls elongating the bar in one direction only. The heavy revolving rolls by their transverse pressure on the bar, force the fibres in it to occupy a lateral position. So long as the bar passes between these rolls endwise, the fibre will exist in this direction. Let the bar, however, be passed sideways a few times, and their direction will be totally changed. If a short piece is cut from off the end of a fibrous bar, and rolled a few times in a direction at right angles with its former axis, so as to distend its linear dimension, the fibre will be found running the length of the bar, though at first it was direct across. The direction of the original fibres has been obliterated, and new fibres have been formed. Continuing the rolling in this direction, and a bar of fibrous wrought iron will be produced, equal in tenacity to one rolled continuously in the same direction. It is very evident, however, that at a certain stage in the operation, this rolling of the bar at a right angle to its former direction, will have merely neutralized the effect of the previous rolling, without producing new fibre. If examined at this stage, the bar will be found free from lamina, and equally strong in every direction. It has been discovered by experiment, that to arrive at this point with certainty and precision, the operation must be so conducted that the elongation or distension of the metal shall be similar in each direction. The puddled bars used in the piles, which subsequently formed the rails experimented on, were rolled from blooms about 12 inches long, into bars averaging 12 feet long, by 3 inches wide. Their linear dimension was consequently increased twelve-fold. The short pieces cut from off these bars and laid transversely in the pile, were 7 inches long and 3 inches wide; by the combined lateral and vertical strains which they were subjected to in the operation of rolling the rail, they were distended to nine times their former length, or to 27 inches, long, with a considerable diminution in their breadth and thickness, equivalent on the whole, to the twelve-fold distension by the original rolling.

Apart from the great advantage of a non-laminating metal, the rails prepared under this plan of cross-piling, displayed qualities which rendered them peculiarly valuable for railway purposes. When tested by a heavy weight falling freely on them from a height of fourteen feet, the indentation occasioned by the impact was very much less than that on rails manufactured in the usual way; and tested by supporting them at the ends, and suspending a weight of two tons for a few minutes on their centre, the permanent deflexion was also found greatly in favor of the cross-piling. The mechanical action of the rolls in neutralizing the previous fibrous structure, appears to have condensed the particles of metal, and to have violently expelled the cinder and other extraneous matter with which it was combined. The increased rigidity appears also to have resulted from the increased density of the metal in the upper portion of the bar, offering a greater resisting medium to compression.

This neutralizing the tendency of bar iron to resolve into the fibrous structure, is partially understood in the manufactures of boiler plate and sheet iron. The plan followed in these factories consists in alternately presenting the end and side of the plate to the action of the rolls, whereby the expansion of the metal is equal in each direction; but this procedure, though well adapted to neutralize the formation of fibre when the object operated on is a plain iron plate, is inapplicable in the case of rails by reason of their angular section and great length—circumstances which render it essentially necessary that their movements be in the same plane.

The system of cross-piling herein described, involves a principle of great importance hitherto comparatively unknown to manufacturers of wrought iron. By its application, the tendency of rolled bar iron generally to resolve into the fibrous structure, is effectually prevented. By its application, also, the surface or even the entire depth of rail bars, are hardened so that abrasion from the sliding of the rolling and working stock is reduced, and the rigidity of the rail is increased. The simplicity of the remedy, the facility with which it may be managed, and the unerring certainty that the metal so worked will be devoid of lamina, must eventually secure its introduction into iron works generally.

The beneficial application of the principle, however, is not limited to the manufacture of non-laminating rails; it may be advantageously extended to various descriptions of wrought iron for engineering and building purposes, where a partial or total absence of lamina is desired. In the manufacture of wheel tyres, it will be found especially valuable; in manufacturing roofing and other iron, it may be used with considerable economy of materials; its qualities of rigidity and tenacity combined, will render it of essential service to iron ship builders; to steam boiler makers and others, requiring angle iron possessing a tenacity equal in every direction, it must prove of great importance; while the facility with which the rigidity and hardness of cast iron can be communicated to wrought iron without impairing its tenacity, will doubtless ensure its extensive adoption in the manufacture of malleable iron frames for the engines of ocean-going steamers.

On the Pneumatic Method adopted in constructing the Foundations of the new Bridge across the Medway, at Rochester. By JOHN HUGHES, Assoc. Inst. C. E.*

This bridge was described as being designed to consist of three large openings, a central one of 170 feet in width, and two others, each of 140 feet in width, spanned by cast iron segmental girders, and of a passage to admit masted vessels to the upper parts of the river, across which a moveable bridge would be placed. Each of the river piers occupied an area of 1118 square feet, and rested upon a series of cast iron cylinder piles, 7 feet in diameter, placed 9 feet apart longitudinally, and 10 feet transversely, so that there were fourteen under each pier. The cylinder piles in the abutments were 6 feet in diameter, of which the "Strood" abutment required thirty, and the "Rochester" abutment twelve. Each pile was composed of two, three, or more cylinders, 9 feet in length, bolted together through stout flanches; the bottom length had its lower edge bevelled, so as to faciliate the cutting through the ground. The bed of the river was originally presumed to consist of soft clay, sand, and gravel, overlying the chalk, and accordingly the application of Dr. Potts' pneumatic method for forcing the cylinder piles into the ground, which had been successfully carried out in similar positions, was contemplated; but after a few trials, the ground was found to consist of a compact mass of Kentish ragstone, so that the mere atmospheric action upon the piles, induced by a partial vacuum, would be ineffective in such a situation. It was therefore decided, that the pneumatic process should be reversed, so as to give each pile the character of a diving-bell; for which purpose one of the cylinders, 7 feet in diameter, and 9 feet in length, had a wrought iron cover securely bolted to it, through which two cast iron chambers, D shaped in plan, with a sectional area of about 6 square feet appropriately called "air locks," projected 2 feet 6 inches above the top of the cylinder, and 3 feet 9 inches below the cover. The top of each "air lock" was provided with a circular opening 2 feet in diameter, with a flap working on a horizontal hinge, and an iron door, 2 feet by 3 feet 4 inches, with vertical hinges below the cover; each air lock was also furnished with two sets of cocks, the one for forming a communication between the cylinders and the chamber, and the other between the chamber and the atmosphere. Compressed air was supplied to the cylinder pile by a double-barrelled pump, 12 inches in diameter, and 18 inches stroke, driven by a six horse power non-condensing steam engine. At first the expelled water was made to pass into the river, from beneath the lower edge of the piles, but when the stratum became so compact as to oppose a high degree of resistance to the passage of the air, an outlet was formed through the side of the uppermost cylinder, by the introduction of a pipe having the form of a syphon, the long leg of which reached to the bottom of the pile, and was subject to the pressure of the condensed air on the surface of the water within, whilst the short leg leading into the river, had the effect of relieving the amount of compression, provided a vacuum was once obtained in the body of the syphon. Such an effect was readily produced by connecting the summit with the exhaust side of the air pumps, by a pipe, which could be opened or closed at pleasure. To insure the downward motion of the pile, and to give it a weight which should be at all times superior to the upward pressure, two stout trussed timber beams were laid on the top of the cylinder, in a direction suitable for bringing the adjacent piles into action as counterbalance weights, by four chains passing over cast iron sheaves.

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* From the London Architect, for June, 1851.

Two light wrought-iron cranes were fixed inside the cylinder, the jibs of which swept over the space between the air locks and windlasses, inside and outside, for the purpose of hoisting the loaded buckets, and lowering the empty ones.

The method followed in working the apparatus was found to be so simple in detail, as to be perfectly intelligible to all the workmen employed. The pumps being set in motion, the flap of one of the air locks and the door of the other, were closed; a few strokes compressed the air within the pile sufficiently to seal the joints, and whilst the pumping was in progress, the men passed through the air locks to their respective stations. When the water was shallow, the pile descended, by scarcely sensible degrees, as fast as the excavation by hand permitted; when the water was deep, the excavation was carried down full 14 inches below the edge of the pile, which then descended, at once, through the whole space, as soon as the pressure was eased off.

The most perfect certainty and success had attended the employment of this simple system, and as it promised to afford considerable assistance to engineers in the prosecution of similar works, the author laid the account before the Institution with the sanction of Mr. Cubitt, President Inst. C. E., the engineer-in-chief, and Messrs Fox, Henderson, and Co., the contractors for the works —*Proc. Inst. Civ. Eng. May 13th*, 1851.

Railway over the Soemmering Mountain, Austria.

This railroad is assuredly one of the most important public works ever executed in Europe, both as regards the fact of its establishing a communication with the Adriatic, and the considerable height it has to pass. The number of persons employed, when the greatest activity was displayed in pushing the work forward, amounted to 16,000 men, and 2000 women and children. The cholera broke out last season among these workpeople, in consequence of their not being properly housed, which in some degree even interrupted the progress of the undertaking.

The height of the Soemmering at the spot where the railroad will pass, is 3066 feet above the level of the sea ; but a tunnel is to be bored in the mountain at a height of 2790 feet. 1200 men and twelve steam engines of an aggregate power of 200 horses, are employed in this tunnel, which is called the Soemmering Haupt Tunnel, and the length of which is about one English mile. Four millions cubic feet of stone and earth will have to be displaced, at a cost of 150,000*l*. The estimated cost of the whole Soemmering railway, is 800,000*l*., but will probably amount to a million. As the length is 5 German miles, (20 English), each mile will require an outlay of nearly 200,000*l*. This sum is large ; but the railroad on the Prussian and Belgian frontiers exceeded it, and cannot be compared with that over the Soemmering. Owing to the brittle nature of the limestone rock, the excavation of the tunnel has to be effected with great precaution. The carrying away of the debris, and the bringing in the building materials, through the complicated scaffolding, is very laborious. The arches of the tunnel have, in some places, been made double and treble, one above the other, which are considered better than a single one of the same thickness.

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* From the London Architect, for June, 1851.

But even viewing these operations under the most hopeful aspect, doubts seem now to rise, whether such an expensive and, even when successfully completed, *hazardous* passage might not have been avoided by flanking this whole mountain range, and carrying the road to Trieste through the valleys of Hungary. The most critical points on the line are the many short curves it presents, and steep gradients, in some places 1 in 40 for a length of two English miles.

The time is approaching when the prize of 20,000 ducats (about 10,000*l.*) will be awarded for an engine to surmount all these difficulties. One of the conditions is, that it must be applicable to curves whose radius, in one instance, is no more than 600 feet—one of the most difficult problems ever proposed. Unhappily, the deep snow spreading every winter over these sub-alpine regions, has stayed the progress of the works; and it may, as has been apprehended, stay the traffic, if once completed.

For the Journal of the Franklin Institute.

A New Method of Calculating the Cubic Contents of Excavations and Embankments.—By John C. Trautwine, C. E.

Entered, according to the Act of Congress, in the year 1851, by John C. Trautwine, in the Clerk's Office of the District Court of the United States, for the Eastern District of Pennsylvania.

Continued from page 13.

In the following tables of level cuttings, the left hand vertical column contains the height or depth of the embankment or excavation, in feet; and the upper horizontal column, the intermediate tenths of a foot. Thus in table 1, the cubic yards in a station 100 feet long and 10 feet deep, are 1074; for 10·1 deep, 1090; for 10·2 deep, 1107, &c.

Errata.

The following errata occur in the first portion of this article, in the preceding number of the Journal.

Page 5, Fifth line from the top, for 78°58′, read 75°58′.

" 22 lines from bottom, for *ef* or width of roadway, read *of* or half width of roadway. And in the following four lines, for *ef* read *of*.

Page 8, 16 lines from top, for ½ to 1, read ¼ to 1.

TABLE 1.—LEVEL CUTTINGS.

Roadway 14 *feet wide, side-slopes* 1½ *to* 1.

H'ght in ft.	0	·1	·2	·3	·4	·5	·6	·7	·8	·9
	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds	cu. yds.	cu. yds.	cu. yds.
0		5·24	10·6	16·1	21·6	27·3	33·1	39·0	45·0	51·2
1	57·4	63·8	70·2	76·8	83·5	90·3	97·2	104·2	111·3	118·6
2	125·9	133·4	141·0	148·6	156·4	164·4	172·4	180·5	188·7	197·1
3	205·6	214·1	222·8	231·6	240·5	249·5	258.7	267·9	277·3	286·7
4	296·3	306·0	315·8	325·7	335·7	345.8	356·1	366·4	376·9	387·5
5	398·1	408·9	419·9	430·9	442·0	453·2	461·6	476·1	487·6	499·3
6	511·1	523·0	535·0	547·2	559·4	571·8	584·2	596·8	609·5	622·3
7	635·2	648·2	661·3	674·6	687·9	701·4	714·9	728·6	742·4	756.3
8	770·3	784·5	798·7	813·1	827·5	842·1	856·8	871·6	886·5	901·5
9	916·7	931·9	947·3	962·7	978·3	991·0	1010	1026	1042	1058
10	1074	1090	1107	1123	1140	1157	1174	1191	1208	1225
11	1243	1260	1278	1295	1313	1331	1349	1367	1385	1404
12	1422	1441	1459	1478	1497	1516	1535	1554	1574	1593
13	1613	1633	1652	1672	1692	1712	1733	1753	1773	1794
14	1815	1835	1856	1877	1898	1920	1941	1962	1984	2906
15	2028	2050	2072	2094	2116	2138	2161	2183	2206	2229
16	2252	2275	2298	2321	2344	2368	2391	2415	2139	2463
17	2187	2511	2535	2559	2584	2608	2633	2658	2683	2708
18	2733	2759	2784	2809	2835	2861	2886	2912	2938	2964
19	2991	3017	3044	3070	3097	3124	3151	3178	3205	3232
20	3259	3287	3314	3342	3370	3398	3426	3454	3482	3510
21	3539	3557	3586	3615	3644	3673	3702	3731	3761	3790
22	3820	3849	3879	3909	3939	3969	3999	4030	4060	4091
23	4132	4162	4193	4224	4255	4287	4318	4349	4381	4113
24	4444	4476	4508	4541	4573	4605	4638	4670	4703	4736
25	4769	4802	4835	4868	4901	4935	4968	5002	5036	5970
26	5104	5138	5172	5206	5241	5275	5310	5345	5330	5415
27	5450	5485	5521	5556	5592	5627	5663	5699	5735	5771
28	5807	5844	5880	5917	5953	5990	6027	6064	6101	6139
29	6176	6213	6251	6289	6326	6364	6402	6440	6479	6517
30	6556	6594	6633	6672	6711	6750	6789	6828	6867	6907
31	6946	6986	7026	7066	7106	7146	7186	7226	7267	7307
32	7348	7389	7430	7471	7512	7553	7596	7636	7678	7719
33	7761	7803	7845	7887	7929	7972	8014	8057	8099	8142
34	8185	8228	8271	8315	8358	8401	8445	8489	8532	8576
35	8620	8664	8709	8753	8798	8842	8887	8932	8976	9022
36	9067	9112	9157	9203	9248	9294	9340	9386	9432	9478
37	9524	9570	9617	9663	9710	9757	9804	9851	9898	9945
38	9993	10040	10088	10135	10183	10231	10279	10327	10375	10121
39	10472	10521	10569	10618	10667	10716	10765	10815	10864	10913
40	10963	11012	11062	11112	11162	11212	12263	11313	11364	11414
41	11465	11516	11567	11618	11669	11720	11771	11823	11874	11926
42	11978	12029	12081	12134	12186	12238	12291	12343	12396	12149
43	12502	12555	12608	12661	12715	12768	12822	12875	12929	12983
44	13037	13091	13115	13200	13254	13309	13363	13418	13473	13528
45	13583	13639	13694	13749	13805	13861	13916	13972	14028	14084
46	14141	14197	14254	14310	14367	14424	14480	14537	14595	14652
47	14709	14767	14821	14882	14940	14998	15056	15114	15172	15230
48	15289	15347	15106	15165	15521	15583	15642	15701	15761	15820
49	15880	15939	15999	16059	16119	16179	16239	16300	16360	16121
50	16181	16542	16603	16664	16725	16787	16848	16969	16971	17033
51	17094	17156	17218	17281	17313	17405	17167	17530	17593	17656
52	17719	17782	17815	17908	17971	18035	18098	18162	18226	18299
53	18354	18118	18182	18516	18611	18675	18740	18805	18870	18935
54	19000	19065	19131	19196	19262	19327	19393	19159	19525	19591
55	19657	19724	19790	19857	19923	19990	20057	20121	20191	20259
56	20326	20393	20161	20529	20596	20664	20732	20800	20869	20937
57	21005	21074	21113	21212	21280	21349	21419	21488	21557	21627
58	21696	21766	21836	21906	21976	22016	22116	22186	22257	22327
59	22398	22169	22540	22611	22682	22753	22825	22896	22968	23039
60	23111	23183	23255	23327	23399	23472	23544	23617	23689	23762

For continuation to 100 feet see Table 13.

Table 2.—LEVEL CUTTINGS.

Roadway 24 feet wide, side-slopes 1½ to 1.

H'ght in ft.	·0	·1	·2	·3	·4	·5	·6	·7	·8	·9
	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.
0		8·94	18·0	27·2	36·4	45·8	55·3	64·9	74·7	84·5
1	94·4	104·5	114·7	124·9	135·3	145·8	156·4	167·2	178·0	188·9
2	200·0	211·2	222·4	233·8	245·3	256·9	268·6	280·5	292·4	304·4
3	316·6	328·9	341·2	353·7	366·3	379·0	391·9	404·8	417·8	431·0
4	444·4	457·8	471·3	484·9	498·6	512·4	526·4	540·4	554·6	568·8
5	583·3	597·8	612.4	627·1	642·0	656·9	671·9	687·1	702.3	717·7
6	733·3	748·9	764·7	780·5	796·4	812·5	828·7	844·9	861·3	877·8
7	894·4	911·2	928.0	944·9	962·0	979·2	996·4	1014	1031	1049
8	1067	1085	1102	1121	1139	1157	1175	1194	1212	1231
9	1250	1269	1288	1307	1326	1346	1365	1385	1405	1425
10	1444	1465	1485	1505	1525	1546	1566	1587	1608	1629
11	1650	1671	1692	1714	1735	1757	1779	1800	1822	1845
12	1867	1889	1911	1934	1956	1979	2002	2025	2048	2671
13	2094	2118	2141	2165	2189	2213	2236	2261	2285	2309
14	2333	2358	2382	2407	2432	2457	2482	2507	2532	2558
15	2583	2609	2635	2661	2686	2713	2739	2765	2791	2818
16	2844	2871	2898	2925	2952	2979	3006	3034	3061	3089
17	3117	3145	3172	3201	3229	3257	3285	3314	3342	3371
18	3400	3429	3458	3487	3516	3546	3575	3605	3635	3665
19	3694	3725	3755	3785	3815	3846	3876	3907	3938	3969
20	4000	4031	4062	4094	4125	4157	4189	4221	4252	4285
21	4317	4349	4381	4414	4446	4479	4512	4545	4578	4621
22	4644	4678	4711	4745	4779	4813	4846	4881	4915	4949
23	4983	5018	5052	5087	5122	5157	5192	5227	5262	5298
24	5333	5369	5405	5441	5476	5513	5549	5585	5621	5658
25	5694	5731	5768	5805	5842	5879	5916	5954	5991	6029
26	6067	6105	6142	6181	6219	6257	6295	6334	6372	6411
27	6450	6489	6528	6567	6606	6646	6685	6725	6765	6805
28	6844	6885	6925	6965	7005	7046	7086	7127	7168	7209
29	7250	7291	7332	7374	7415	7457	7499	7541	7582	7625
30	7667	7709	7751	7794	7836	7879	7922	7965	8008	8051
31	8094	8138	8181	8225	8269	8313	8356	8401	8445	8489
32	8533	8578	8622	8667	8712	8757	8802	8847	8892	8938
33	8983	9029	9075	9121	9166	9212	9259	9305	9351	9398
34	9444	9491	9538	9585	9632	9679	9726	9774	9821	9869
35	9917	9965	10012	10061	10109	10157	10205	10254	10302	10351
36	10400	10449	10498	10547	10596	10646	10695	10745	10795	10845
37	10894	10945	10995	11045	11095	11146	11196	11247	11298	11349
38	11400	11451	11502	11554	11605	11657	11709	11761	11812	11865
39	11917	11969	12021	12074	12126	12179	12232	12285	12338	12391
40	12444	12498	12551	12605	12659	12713	12766	12821	12875	12929
41	12983	13038	13092	13147	13202	13257	13312	13367	13422	13478
42	13533	13589	13645	13701	13756	13813	13869	13925	13981	14038
43	14094	14151	14208	14265	14322	14379	14436	14494	14551	14609
44	14667	14725	14782	14810	14899	14957	15015	15074	15132	15191
45	15250	15309	15368	15427	15486	15546	15605	15665	15725	15785
46	15844	15905	15965	16025	16085	16146	16206	16267	16328	16389
47	16450	16511	16572	16634	16695	16757	16819	16881	16942	17005
48	17067	17129	17191	17254	17316	17379	17442	17505	17568	17631
49	17694	17758	17821	17885	17949	18013	18976	18141	18205	18269
50	18333	18398	18462	18527	18592	18657	18722	18787	18852	18918
51	18983	19049	19115	19181	19246	19313	19379	19445	19511	19578
52	19644	19711	19778	19845	19912	19979	20046	20114	20181	20249
53	20317	20385	20452	20521	20589	20657	20725	20794	20862	20931
54	21000	21069	21138	21207	21276	21346	21415	21485	21555	21625
55	21694	21765	21835	21905	21975	22046	22116	22187	22258	22329
56	22400	22471	22542	22614	22685	22757	22829	22901	22972	23045
57	23117	23189	23261	23334	23406	23479	23552	23625	23698	23771
58	23844	23918	23991	24065	24139	24213	24286	24361	24435	24509
59	24583	24658	24732	24807	24882	24957	25032	25107	25182	25258
60	25333	25409	25485	25561	25636	25713	25789	25865	25941	26018

For continuation to 100 feet, see table 13.

TABLE 3.—LEVEL CUTTINGS.

Roadway 18 *feet wide, side-slopes* 1 *to* 1.

Depth in ft.	·0	·1	·2	·3	·4	·5	·6	·7	·8	·9
	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.
0		6·70	13·5	20·3	27·3	34·3	41·5	48·5	55·7	63·0
1	70.4	77·8	85·3	92·9	100·6	108·3	116·1	124·0	132·0	140·0
2	148·1	156·3	164·6	172·9	181·3	189·8	198·4	207·0	215·7	224·5
3	233·3	242·3	251·3	260·3	269·5	278·7	288·0	297·4	306·8	316·3
4	325·9	335·6	345·3	355·1	365·0	375·0	385·0	395·1	405·3	415·6
5	425·9	436·3	446·8	457·4	468·0	478·7	489·5	500.3	511·3	522·3
6	533·3	544·5	555·7	567·0	578·4	589·8	601·2	612·9	624·6	636·3
7	618·1	660·0	672·0	684·0	696·1	708·3	720·6	732·9	745·3	757·8
8	770·4	783·0	795·7	808·5	821·3	834·3	847·3	860·3	873·5	886·7
9	900·0	913·4	926·8	940·3	953·9	967·6	981·3	995·1	1009	1023
10	1037	1051	1065	1080	1094	1108	1123	1137	1152	1167
11	1181	1196	1211	1226	1241	1256	1272	1287	1302	1318
12	1333	1349	1365	1380	1396	1412	1428	1444	1460	1476
13	1493	1509	1525	1512	1558	1575	1592	1608	1625	1642
14	1659	1676	1693	1711	1728	1745	1763	1780	1798	1816
15	1833	1851	1869	1887	1905	1923	1941	1960	1978	1996
16	2015	2033	2052	2071	2089	2108	2127	2146	2165	2184
17	2204	2223	2242	2262	2281	2301	2321	2340	2360	2380
18	2400	2420	2440	2460	2481	2501	2521	2542	2562	2583
19	2604	2624	2615	2666	2687	2708	2729	2751	2772	2793
20	2815	2836	2858	2880	2901	2923	2945	2967	2989	3011
21	3033	3056	3078	3100	3123	3145	3168	3191	3213	3236
22	3259	3282	3305	3328	3352	3375	3398	3422	3445	3469
23	3493	3516	3540	3564	3588	3612	3636	3660	3685	3709
24	3733	3758	3782	3807	3832	3856	3881	3906	3931	3956
25	3981	4007	4032	4057	4083	4108	4134	4160	4185	4211
26	4237	4263	4289	4315	4341	4368	4394	4420	4447	4473
27	4500	4527	4553	4580	4607	4634	4661	4688	4716	4743
28	4770	4798	4825	4853	4881	4908	4936	4964	4992	5020
29	5048	5076	5105	5133	5161	5190	5218	5247	5276	5304
30	5333	5362	5391	5420	5149	5479	5508	5537	5567	5596
31	5626	5656	5685	5715	5745	5775	5805	5835	5865	5896
32	5926	5956	5987	6017	6048	6079	6109	6140	6171	6202
33	6233	6264	6296	6327	6358	6390	6421	6453	6486	6516
34	6548	6580	6612	6644	6676	6708	6741	6773	6805	6838
35	6870	6903	6936	6968	7001	7034	7067	7100	7133	7167
36	7200	7233	7267	7300	7334	7368	7401	7435	7469	7503
37	7537	7571	7605	7640	7674	7708	7743	7777	7812	7847
38	7881	7916	7951	7986	8021	8056	8092	8127	8162	8198
39	8233	8269	8305	8340	8376	8412	8148	8484	8520	8556
40	8593	8629	8665	8702	8738	8775	8812	8818	8885	8922
41	8959	8996	9033	9071	9108	9145	9183	9220	9258	9296
42	9333	9371	9409	9447	9485	9523	9561	9600	9638	9676
43	9715	9753	9792	9831	9869	9908	9947	9986	10025	10061
44	10101	10143	10182	10222	10261	16301	10341	10380	10420	10460
45	10500	10540	10580	10620	10661	10701	10741	10782	10822	10863
46	10904	10914	10985	11026	11067	11108	11149	11191	11232	11273
47	11315	11356	11398	11440	11481	11523	11565	11607	11649	11691
48	11733	11776	11818	11860	11903	11945	11988	12031	12073	12116
49	12159	12202	12245	12288	12332	12375	12418	12462	12505	12519
50	12593	12636	12680	12724	12768	12812	12857	12900	12915	12989
51	13033	13078	13122	13167	13212	13256	13301	13346	13391	13436
52	13481	13527	13572	13617	13663	13708	13754	13800	13815	13891
53	13937	13983	14029	14075	14121	14168	14214	14260	14307	14353
54	14400	14147	14193	14540	14587	14634	14681	14728	14776	14823
55	14870	14918	14965	15013	15061	15108	15156	15204	15252	15300
56	15348	15396	15445	15493	15541	15590	15638	15687	15736	15784
57	15833	15882	15931	15980	16029	16079	16128	16177	16227	16276
58	16326	16376	16425	16475	16525	16575	16625	16675	16725	16776
59	16826	16876	16927	16977	17028	17079	17129	17180	17231	17282
60	17333	17384	17436	17487	17538	17590	17641	17693	17745	17796

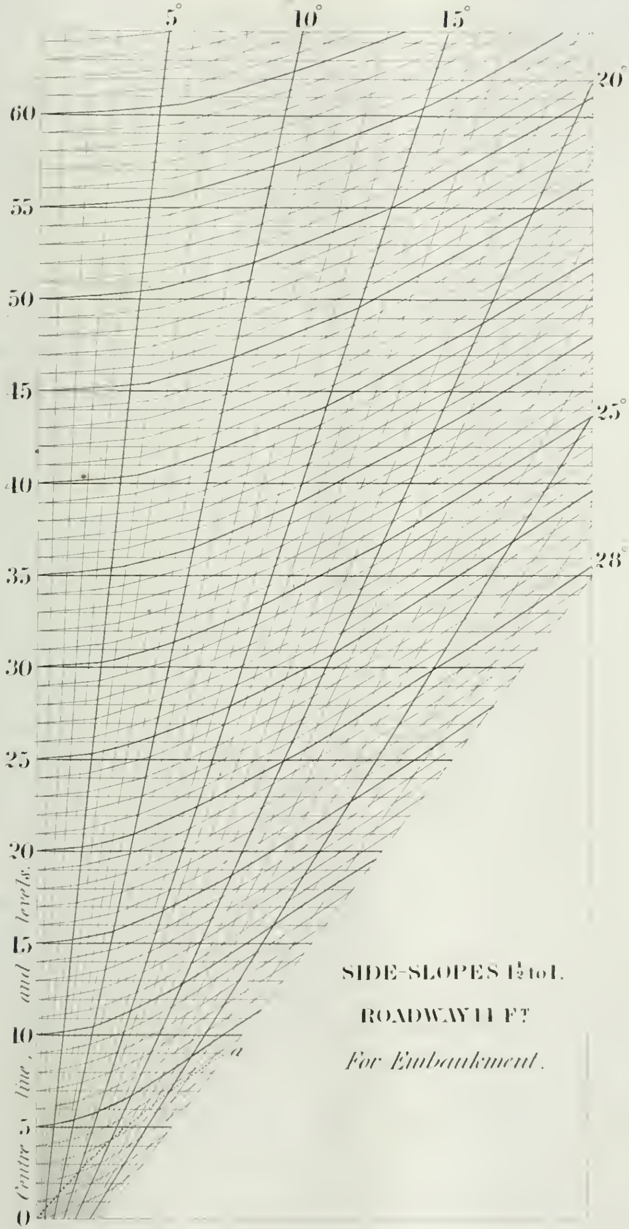
For continuation to 100 feet see table 13.

TABLE 4.—LEVEL CUTTINGS.

Roadway 18 *feet wide, side-slopes* 1¼ *to* 1.

Depth in ft.	·0	·1	·2	·3	·4	·5	·6	·7	·8	·9
	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.
0		6·71	13·5	20·4	27·4	34·5	41·6	49·0	56·0	64·0
1	71·3	78·9	86·7	94·5	102·4	110·4	118·5	126·7	135·0	143·4
2	151·8	160·4	169·1	177·8	186·7	195·6	204·6	213·8	223·0	232·3
3	241·6	251·1	260·7	270·4	280·2	290·0	300·0	310·1	320·2	330·5
4	340·7	351·2	361·7	372·3	383·0	393·8	404·7	415.7	426·8	437·9
5	449·2	460·6	472·1	483·7	495·3	507·0	518·8	530·8	542·8	554·9
6	566·7	579·0	591·3	603·8	616·4	629·0	641.8	654·5	667·5	680.4
7	693·5	706·7	720·0	733·4	746·9	760·4	774·1	787·8	801·7	815·6
8	829·6	843·8	858·0	872·3	886·7	901·2	915·8	930·4	945·2	960·1
9	975·0	990·0	1005	1020	1036	1051	1067	1082	1098	1114
10	1130	1146	1162	1178	1194	1210	1227	1243	1260	1277
11	1293	1310	1327	1344	1361	1379	1396	1413	1431	1448
12	1467	1484	1502	1520	1539	1557	1575	1593	1612	1630
13	1649	1668	1687	1706	1725	1744	1763	1782	1802	1821
14	1841	1860	1880	1900	1920	1940	1960	1980	2001	2021
15	2042	2062	2083	2104	2125	2146	2167	2188	2209	2231
16	2252	2273	2295	2317	2339	2361	2383	2405	2427	2449
17	2471	2494	2516	2539	2562	2585	2608	2631	2654	2677
18	2700	2723	2747	2770	2794	2818	2842	2866	2890	2914
19	2938	2962	2987	3011	3036	3060	3085	3110	3135	3160
20	3185	3210	3236	3261	3287	3312	3338	3364	3390	3416
21	3442	3468	3494	3520	3547	3573	3600	3627	3654	3680
22	3707	3734	3762	3789	3816	3844	3871	3899	3927	3954
23	3982	4010	4039	4067	4095	4123	4152	4180	4209	4238
24	4267	4296	4325	4354	4383	4412	4442	4471	4501	4530
25	4560	4590	4620	4650	4680	4710	4741	4771	4802	4832
26	4863	4894	4925	4956	4987	5018	5049	5080	5112	5143
27	5175	5207	5239	5270	5302	5334	5367	5399	5431	5464
28	5496	5529	5562	5594	5627	5660	5693	5727	5760	5793
29	5827	5860	5894	5928	5962	5996	6030	6064	6098	6132
30	6167	6201	6236	6270	6305	6340	6375	6410	6445	6480
31	6516	6551	6587	6622	6658	6694	6730	6766	6802	6838
32	6874	6910	6947	6983	7020	7057	7093	7130	7167	7204
33	7242	7279	7316	7354	7391	7429	7467	7504	7542	7580
34	7618	7656	7695	7733	7772	7810	7849	7887	7926	7965
35	8005	8044	8083	8122	8162	8201	8241	8280	8320	8360
36	8400	8440	8480	8520	8561	8601	8642	8682	8723	8764
37	8805	8846	8887	8928	8969	9010	9052	9093	9135	9177
38	9219	9260	9302	9344	9387	9429	9471	9514	9556	9599
39	9612	9684	9727	9770	9813	9857	9900	9943	9987	10030
40	10074	10118	10162	10206	10250	10294	10338	10382	10427	10471
41	10516	10560	10605	10650	10695	10740	10785	10830	10876	10921
42	10967	11012	11058	11104	11150	11196	11242	11288	11334	11380
43	11427	11473	11520	11567	11614	11660	11707	11754	11802	11849
44	11896	11944	11991	12039	12087	12134	12182	12230	12278	12327
45	12375	12423	12472	12520	12569	12618	12667	12716	12765	12814
46	12863	12912	12962	13011	13061	13111	13160	13210	13260	13310
47	13360	13410	13461	13511	13562	13613	13662	13713	13764	13815
48	13867	13918	13969	14020	14072	14123	14175	14227	14279	14330
49	14382	14435	14487	14539	14591	14644	14696	14749	14802	14855
50	14907	14960	15014	15067	15120	15173	15227	15280	15334	15388
51	15442	15496	15550	15604	15658	15712	15767	15821	15876	15931
52	15985	16040	16095	16150	16205	16260	16316	16371	16427	16482
53	16538	16591	16650	16706	16761	16817	16874	16930	16987	17043
54	17100	17157	17214	17270	17328	17385	17441	17499	17556	17613
55	17671	17729	17787	17845	17903	17961	18019	18077	18135	18193
56	18252	18310	18369	18428	18487	18545	18604	18663	18723	18782
57	18842	18901	18961	19021	19080	19140	19200	19260	19320	19380
58	19441	19501	19562	19622	19683	19744	19804	19865	19926	19988
59	20049	20110	20172	20233	20295	20357	20418	20480	20542	20604
60	20667	20729	20791	20854	20916	20979	21041	21104	21167	21230

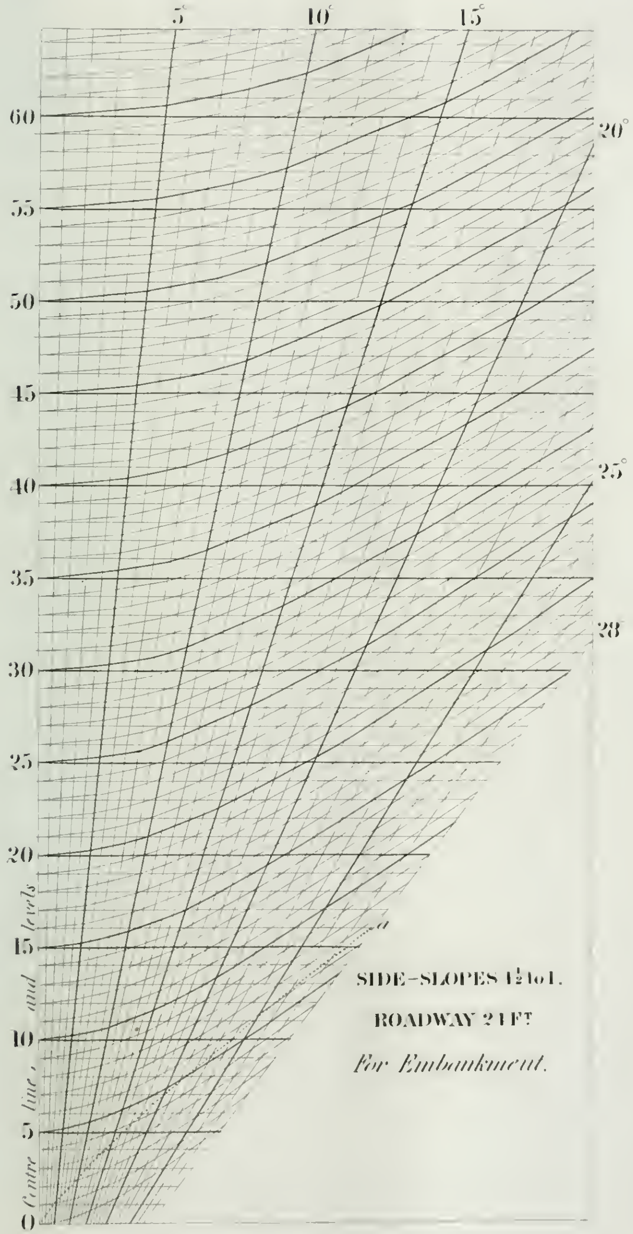
For continuation to 100 feet see table 13.



SIDE-SLOPES 1½ to 1.

ROADWAY 14 FT.

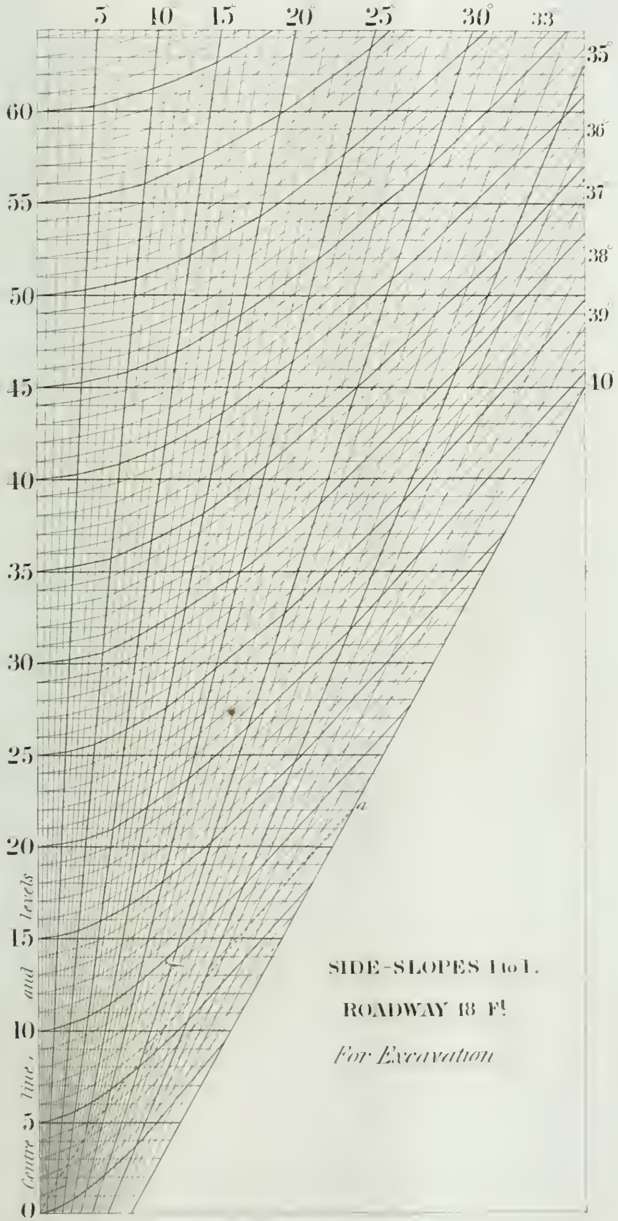
For Embankment.



SIDE-SLOPES 1½ to 1.

ROADWAY 24 FT.

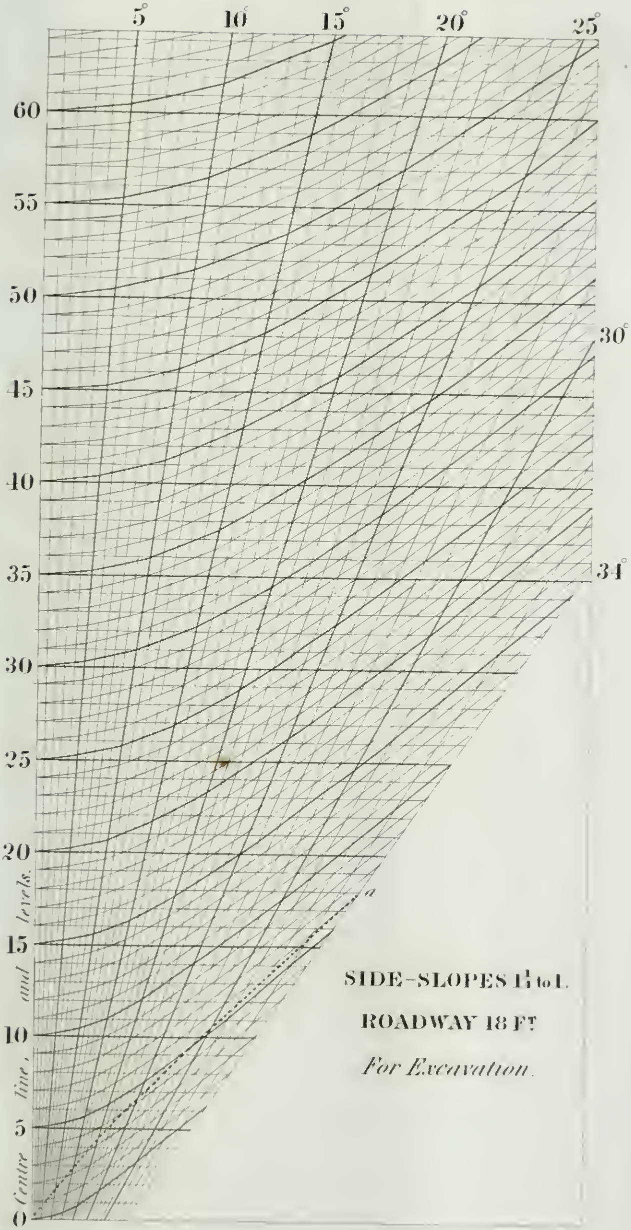
For Embankment.



SIDE-SLOPES 1 to 1.

ROADWAY 18 Ft.

For Excavation



SIDE-SLOPES $1\frac{1}{4}$ to 1.

ROADWAY 18 F$^{\text{T}}$

For Excavation.

TABLE 5.—LEVEL CUTTINGS.

Roadway 18 *feet wide, side-slopes* 1½ *to* 1.

Depth in ft.	·0	·1	·2	·3	·4	·5	·6	·7	·8	·9
	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.
0		6·72	13·6	20·5	27·6	34·7	42.0	49·4	56·9	64·5
1	72·2	80·1	88·0	96·1	104·2	112·5	120·9	129·4	138·0	146·7
2	155·5	164·5	173·5	182·7	191·9	201·3	210·8	220·4	230·1	240·0
3	249·9	260·0	270·1	280·4	290·8	301·3	311·9	322·6	333·4	344·5
4	355·5	366·7	378·0	389·4	400·9	412·5	424·2	436·0	448·0	460·0
5	472·2	484·5	496·9	509·4	522·0	534·7	547·6	560·5	573·6	586·7
6	600·0	613·4	626·9	640·5	654·2	668·1	682·0	696·1	710·2	724·5
7	738·9	753·4	768·0	782·7	797·6	812·5	827·6	842·7	858·0	873·4
8	888·9	904·5	920·2	936·1	952·0	968·1	984·2	1001	1017	1033
9	1050	1067	1084	1101	1118	1135	1152	1169	1187	1265
10	1222	1241	1258	1276	1294	1313	1331	1349	1368	1387
11	1406	1425	1444	1463	1482	1501	1521	1541	1560	1580
12	1600	1620	1640	1661	1681	1701	1722	1743	1964	1785
13	1806	1827	1848	1869	1891	1913	1934	1956	1978	2000
14	2022	2045	2067	2089	2112	2135	2158	2181	2204	2227
15	2250	2273	2297	2321	2344	2368	2392	2416	2440	2465
16	2489	2513	2538	2563	2588	2613	2638	2663	2688	2713
17	2739	2765	2790	2816	2842	2868	2894	2921	2947	2973
18	3000	3027	3054	3081	3108	3135	3162	3189	3217	3245
19	3272	3300	3328	3356	3384	3413	3441	3469	3498	3527
20	3556	3585	3614	3643	3672	3701	3731	3761	3790	3820
21	3850	3880	3910	3941	3971	4001	4032	4063	4094	4125
22	4156	4187	4218	4249	4281	4313	4344	4376	4408	4440
23	4472	4505	4537	4569	4602	4635	4668	4701	4734	4767
24	4800	4833	4867	4901	4934	4968	5002	5036	5070	5105
25	5139	5173	5208	5243	5278	5313	5348	5383	5418	5453
26	5489	5525	5560	5596	5632	5668	5704	5741	5777	5814
27	5850	5887	5924	5961	5998	6035	6072	6109	6147	6185
28	6222	6260	6298	6336	6374	6413	6451	6489	6528	6567
29	6606	6645	6684	6723	6762	6801	6841	6881	6920	6960
30	7000	7040	7080	7121	7161	7201	7242	7283	7324	7365
31	7406	7447	7488	7529	7571	7613	7654	7696	7738	7780
32	7822	7865	7907	7949	7992	8035	8078	8121	8164	8207
33	8250	8293	8337	8381	8424	8468	8512	8556	8600	8645
34	8689	8733	8778	8823	8868	8913	8958	9003	9048	9093
35	9139	9185	9230	9276	9322	9368	9414	9461	9507	9553
36	9600	9647	9694	9741	9788	9835	9882	9929	9977	10025
37	10072	10120	10168	10216	10264	10313	10361	10409	10458	10507
38	10556	10605	10654	10703	10752	10801	10851	10901	10950	11000
39	11050	11100	11150	11200	11251	11301	11352	11403	11454	11505
40	11556	11607	11658	11709	11761	11813	11864	11916	11968	12020
41	12072	12125	12177	12229	12282	12335	12388	12441	12494	12547
42	12600	12653	12707	12761	12814	12868	12922	12776	13030	13085
43	13139	13193	13248	13303	13358	13413	13468	13523	13578	13633
44	13689	13745	13800	13856	13912	13968	14024	14081	14137	14193
45	14250	14307	14364	14421	14478	14535	14592	14649	14707	14765
46	14822	14880	14938	14996	15054	15113	15171	15229	15288	15347
47	15406	15465	15524	15583	15642	15701	15761	15821	15880	15940
48	16000	16060	16120	16181	16241	16301	16362	16423	16484	16545
49	16606	16667	16728	16789	16851	16913	16974	17036	17098	17160
50	17222	17285	17347	17409	17472	17535	17598	17661	17724	17787
51	17850	17913	17977	18041	18104	18168	18232	18296	18360	18425
52	18489	18553	18618	18683	18748	18813	18878	18943	19008	19073
53	19139	19205	19270	19336	19402	19468	19534	19601	19667	19733
54	19800	19867	19934	20000	20068	20135	20202	20269	20337	20405
55	20472	20540	20608	20676	20744	20813	20881	20949	21018	21087
56	21156	21225	21294	21363	21432	21501	21571	21641	21710	21780
57	21850	21920	21990	22061	22131	22201	22272	22343	22414	22485
58	22556	22627	22698	22769	22841	22913	22984	23056	23128	23200
59	23272	23345	23417	23489	23562	23635	23708	23781	23854	23927
60	24000	24073	24147	24221	24294	24368	24442	24516	24590	24665

For continuation to 100 feet see table 13.

Table 6.—LEVEL CUTTINGS.

Roadway 18 *feet wide, side-slopes* 2 *to* 1.

Depth in ft.	·0	·1	·2	·3	·4	·5	·6	·7	·8	·9
	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.
0		6·74	13·6	20·7	27·9	35·2	42·7	50·3	58·1	66·0
1	74·1	82·3	90·7	99·2	107·9	116·7	125·6	134·7	144·0	153·4
2	163·0	172·7	182·5	192·5	202·7	213·0	223·4	234·0	244·7	255·6
3	266·7	277·9	289·2	300·7	312·3	324·1	336·0	348·1	360·3	372·7
4	385·2	369·9	410·7	423·6	436·7	450·0	463·4	477·0	490.7	504.5
5	518·5	532·7	547·0	561·4	576·0	590·7	605·6	620·7	635·9	651·2
6	666·7	682·3	698·1	714·0	730·1	746·3	762·7	779·2	795·9	812·7
7	829·6	846·7	864·0	881·4	899·0	916·7	934·5	952·5	970·7	989·0
8	1007	1026	1045	1064	1083	1102	1121	1141	1160	1180
9	1200	1220	1240	1261	1281	1302	1323	1344	1365	1386
10	1407	1429	1451	1473	1495	1517	1539	1561	1584	1607
11	1630	1673	1676	1699	1723	1746	1770	1794	1818	1842
12	1867	1891	1916	1941	1966	1991	2016	2041	2067	2093
13	2119	2143	2171	2197	2223	2250	2277	2304	2331	2358
14	2385	2413	2440	2468	2496	2524	2552	2581	2609	2638
15	2667	2696	2725	2754	2783	2813	2843	2873	2903	2933
16	2963	2993	3024	3055	3086	3117	3148	3179	3211	3242
17	3274	3306	3338	3370	3403	3435	3468	3501	3534	3567
18	3600	3633	3667	3701	3735	3769	3803	3837	3871	3966
19	3941	3976	4011	4046	4081	4117	4152	4188	4224	4260
20	4296	4333	4369	4406	4443	4480	4517	4554	4591	4629
21	4667	4705	4743	4781	4819	4857	4896	4935	4974	5013
22	5052	5091	5131	5170	5210	5250	5290	5330	5371	5411
23	5452	5493	5534	5575	5616	5657	5699	5741	5783	5825
24	5867	5909	5951	5994	6037	6080	6123	6166	6209	6253
25	6296	6340	6384	6428	6472	6517	6561	6606	6651	6696
26	6741	6786	6831	6876	6923	6969	7015	7061	7107	7153
27	7200	7247	7294	7341	7388	7435	7483	7530	7578	7626
28	7674	7722	7771	7819	7868	7917	7966	8015	8064	8113
29	8163	8213	8263	8313	8363	8413	8463	8514	8565	8616
30	8667	8718	8769	8821	8872	8924	8976	9028	9080	9133
31	9185	9238	9291	9344	9397	9450	9503	9557	9611	9665
32	9719	9773	9827	9881	9936	9991	10046	10101	10156	10211
33	10267	10322	10378	10434	10490	10546	10603	10659	10716	10773
34	10830	10887	10944	11001	11059	11117	11175	11233	11291	11349
35	11407	11466	11525	11584	11643	11762	11761	11821	11880	11940
36	12000	12060	12120	12181	12241	12302	12363	12424	12485	12546
37	12607	12669	12731	12793	12855	12917	12979	13041	13104	13167
38	13230	13293	13356	13419	13482	13546	13610	13674	13738	13802
39	13867	13931	13996	14061	14126	14191	14256	14321	14387	14453
40	14519	14585	14651	14717	14783	14850	14917	14984	15051	15118
41	15185	15253	15320	15388	15456	15524	15592	15661	15729	15798
42	15867	15936	16005	16074	16143	16213	16283	16353	16423	16493
43	16563	16633	16704	16775	16846	16917	16988	17059	17131	17202
44	17274	17346	17418	17490	17563	17635	17708	17781	17854	17927
45	18000	18073	18147	18221	18295	18369	18443	18517	18591	18666
46	18741	18816	18891	18966	19041	19117	19192	19268	19344	19420
47	19496	19573	19649	19726	19803	19880	19957	20034	20111	20189
48	20267	20345	20423	20501	20579	20657	20736	20815	20894	20973
49	21052	21131	21211	21290	21370	21450	21530	21610	21691	21771
50	21852	21933	22014	22095	22176	22257	22339	22421	22503	22585
51	22667	22749	22831	22911	22997	23080	23163	23246	23329	23413
52	23496	23580	23664	23748	23832	23917	24001	24086	24171	24256
53	24341	24426	24511	24597	24683	24769	24855	24941	25027	25113
54	25200	25287	25374	25461	25548	25635	25723	25810	25898	25986
55	26071	26162	26251	26339	26428	26517	26606	26695	26784	26873
56	26963	27053	27143	27233	27323	27413	27503	27594	27685	27776
57	27867	27958	28049	28141	28232	28324	28416	28508	28600	28693
58	28785	28878	28971	29064	29157	29250	29343	29437	29531	29625
59	29519	29813	29907	30001	30096	30191	30286	30381	30476	30571
60	30767	30762	30858	30954	31050	31146	31242	31339	31436	31533

For continuation to 100 feet, see table 13.

TABLE 7.—LEVEL CUTTINGS.

Roadway 28 feet wide, side-slopes 1 to 1.

Depth in ft.	·0	1.	·2	·3	·4	·5	·6	·7	·8	·9
	cu. yds	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.
0		10·4	20·9	31·4	42·1	52·8	63·6	74·4	85·3	96·3
1	107·4	118·6	129·8	141·1	152·4	163.9	175·4	187·0	198·7	210·4
2	222·2	234·1	246·1	258·1	270·2	282·4	294.7	307·0	319·4	331·9
3	344·4	357·1	369·8	382·6	395·4	408·3	421·3	434·4	447·6	460·8
4	474·1	487·4	500·9	514·1	528·0	541·7	555·4	569·2	583·1	597·1
5	611·1	625·2	639·4	653·7	668·0	682·4	696·9	711·4	726·1	740·8
6	755·6	770·4	785·4	800·4	815·5	830·6	845·8	861·1	876·5	891·9
7	907·5	923·0	938·7	954·5	970·3	986·2	1002	1018	1034	1050
8	1067	1083	1099	1116	1132	1149	1166	1182	1199	1216
9	1233	1250	1267	1285	1302	1319	1337	1354	1372	1390
10	1407	1425	1443	1461	1479	1497	1515	1534	1552	1570
11	1589	1607	1626	1645	1664	1682	1701	1720	1739	1759
12	1778	1797	1816	1836	1855	1875	1895	1914	1934	1954
13	1974	1994	2014	2034	2055	2075	2095	2116	2136	2157
14	2178	2199	2219	2240	2261	2282	2304	2325	2316	2367
15	2389	2410	2432	2454	2475	2497	2519	2541	2563	2585
16	2607	2630	2652	2674	2697	2719	2742	2765	2788	2810
17	2833	2856	2879	2903	2926	2949	2972	2996	3019	3043
18	3067	3090	3114	3138	3162	3186	3210	3234	3259	3283
19	3307	3332	3356	3381	3406	3431	3455	3480	3505	3530
20	3556	3581	3606	3631	3657	3682	3708	3734	3759	3785
21	3811	3837	3863	3889	3915	3942	3968	3994	4021	4047
22	4074	4101	4128	4154	4181	4208	4235.	4263	4290	4317
23	4344	4372	4399	4427	4455	4482	4510	4538	4566	4594
24	4622	4650	4679	4707	4735	4764	4792	4821	4850	4879
25	4907	4936	4965	4994	5024	5053	5082	5111	5141	5170
26	5200	5230	5259	5289	5319	5349	5379	5409	5439	5470
27	5500	5530	5561	5591	5622	5653	5684	5714	5745	5776
28	5807	5839	5870	5901	5932	5964	5995	6027	6059	6090
29	6122	6154	6186	6218	6250	6282	6315	6347	6379	6412
30	6444	6477	6510	6543	6575	6608	6641	6674	6708	6741
31	6774	6807	6841	6874	6908	6942	6975	7009	7043	7077
32	7111	7145	7179	7214	7248	7282	7317	7351	7386	7421
33	7456	7490	7525	7560	7595	7631	7666	7701	7736	7772
34	7807	7843	7879	7914	7950	7986	8022	8058	8094	8130
35	8167	8203	8239	8276	8312	8349	8386	8423	8459	8496
36	8533	8570	8608	8645	8682	8719	8757	8794	8832	8870
37	8907	8945	8983	9021	9059	9097	9135	9174	9212	9250
38	9289	9327	9366	9405	9444	9482	9521	9560	9599	9639
39	9678	9717	9756	9796	9835	9875	9915	9954	9994	10034
40	10074	10114	10154	10194	10235	10275	10315	10356	10396	10437
41	10478	10519	10559	10600	10641	10682	10724	10765	10806	10847
42	10889	10930	10972	11014	11055	11097	11139	11181	11223	11265
43	11307	11350	11392	11434	11477	11519	11562	11605	11648	11690
44	11733	11777	11819	11863	11906	11949	11992	12036	12079	12123
45	12167	12210	12254	12298	12342	12386	12430	12474	12519	12563
46	12607	12652	12696	12741	12786	12831	12875	12920	12965	13010
47	13056	13101	13146	13191	13237	13282	13328	13374	13419	13465
48	13511	13557	13603	13649	13695	13742	13788	13834	13881	13927
49	13974	14021	14068	14114	14161	14208	14255	14303	14350	14397
50	14444	14492	14539	14587	14635	14682	14730	14778	14826	14874
51	14922	14970	15019	15067	15115	15164	15212	15261	15310	15359
52	15407	15456	15505	15554	15604	15653	15702	15751	15801	15850
53	15900	15950	15999	16049	16099	16149	16199	16249	16299	16350
54	16400	16450	16501	16551	16602	16653	16704	16754	16805	16856
55	16907	16959	17010	17061	17112	17164	17215	17267	17319	17370
56	17422	17474	17526	17578	17630	17682	17735	17787	17839	17892
57	17944	17997	18050	18103	18155	18208	18261	18314	18368	18421
58	18474	18527	18581	18634	18688	18742	18795	18849	18903	18957
59	19011	19065	19119	19174	19228	19282	19337	19391	19446	19501
60	19556	19610	19665	19720	19775	19831	19886	19941	19996	20052

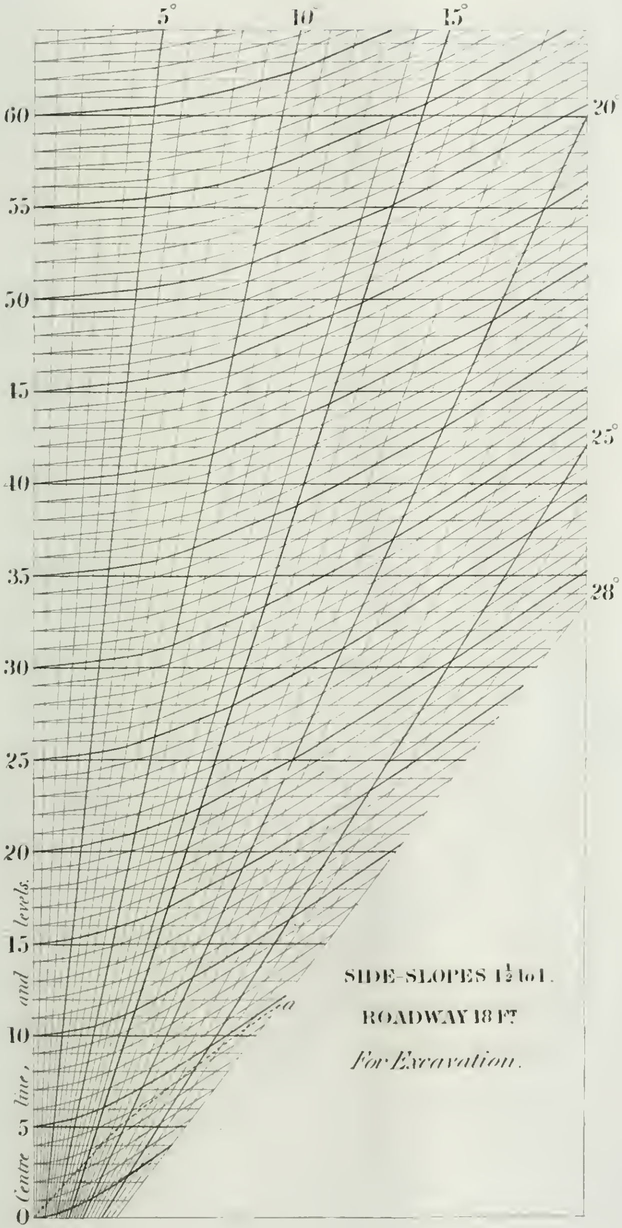
For continuation to 100 feet see table 13.

TABLE 8.—LEVEL CUTTINGS.

Roadway 28 feet wide, side-slopes 1¼ to 1.

Depth in ft.	0	·1	·2	·3	·4	·5	·6	·7	·8	9.
	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds	cu. yds.	cu. yds.	cu. yds.
0		10·4	20·9	31·5	42·2	53·0	63·9	74·9	85·9	97·1
1	108·3	119·7	131·1	142·7	154·3	166·0	177·8	189·7	201·7	213 8
2	225·9	238·2	250·6	263·0	275·6	288·2	301·0	313·8	326·7	339·8
3	352·8	366·0	379·3	392·7	406·2	419·8	433·4	447·2	461·1	475·0
4	488·9	503·0	517·3	531·6	546·0	560·5	575·1	589·8	604·6	619·5
5	634·4	649·5	664·7	679·9	695.3	710·7	726·2	741·9	757·6	773·4
6	788·9	804·9	821·0	837·2	853·4	869·8	886·3	902·8	919·5	936·2
7	952·8	969·8	986·8	1004	1021	1038	1056	1073	1091	1109
8	1126	1144	1162	1180	1198	1216	1234	1252	1271	1289
9	1308	1327	1346	1365	1384	1403	1422	1442	1461	1481
10	1500	1520	1540	1559	1579	1599	1620	1640	1660	1681
11	1701	1722	1742	1763	1784	1805	1826	1847	1869	1890
12	1911	1933	1954	1976	1998	2020	2042	2064	2086	2109
13	2131	2153	2175	2198	2221	2244	2267	2290	2313	2336
14	2359	2382	2406	2429	2153	2477	2501	2525	2549	2573
15	2597	2622	2646	2671	2695	2720	2745	2770	2795	2820
16	2844	2870	2895	2921	2946	2971	2998	2023	3049	2075
17	3101	3127	3153	3180	3206	3233	3259	3286	3313	3340
18	3367	3393	3421	3448	3475	3503	3531	3558	3586	3614
19	3641	3669	3698	3726	3754	3782	3811	3840	3868	3897
20	3925	3954	3984	4013	4042	4071	4101	4130	4160	4189
21	4219	4249	4279	4309	4339	4369	4399	4430	4460	4491
22	4522	4553	4584	4615	4646	4677	4708	4740	4771	4893
23	4834	4866	4898	4930	4962	4994	5026	5058	5091	5123
24	5156	5188	5221	5254	5287	5320	5353	5386	5419	5453
25	5486	5520	5553	5587	5621	5655	5689	5723	5757	5791
26	5826	5860	5895	5930	5964	5999	6034	6069	6104	6140
27	6175	6210	6246	6282	6317	6353	6389	6425	6161	6497
28	6533	6570	6606	6643	6679	6716	6753	6790	6827	6864
29	6901	6938	6976	7013	7051	7088	7126	7164	7202	7240
30	7278	7316	7354	7393	7431	7470	7508	7547	7586	7625
31	7664	7703	7742	7781	7821	7860	7900	7940	7979	8019
32	8059	8099	8139	8180	8220	8260	8301	8341	8382	8423
33	8464	8505	8546	8587	8628	8669	8711	8752	8794	8836
34	8878	8920	8962	9004	9016	9088	9131	9173	9216	9258
35	9301	9344	9387	9430	9473	9516	9559	9603	9646	9689
36	9733	9777	9821	9865	9909	9953	9997	10041	10086	10130
37	10175	10220	10264	10309	10354	10399	10415	10490	10535	10580
38	10626	10672	10717	10763	10809	10855	10901	10946	10993	11040
39	11086	11133	11179	11226	11273	11320	11367	11414	11461	11508
40	11556	11603	11651	11698	11746	11794	11842	11890	11938	11986
41	12035	12083	12131	12180	12228	12277	12326	12375	12424	12473
42	12522	12572	12621	12671	12720	12770	12819	12869	12919	12969
43	13019	13069	13120	13171	13221	13272	13322	13373	13424	13475
44	13526	13577	13628	13680	13731	13782	13834	13886	13938	13990
45	11012	11094	14146	14198	14251	14303	11356	11408	14161	14514
46	14567	11620	14673	14726	14779	11833	14886	14940	14993	15047
47	15101	15155	15209	15263	15317	15372	15426	15480	15535	15590
48	15614	15699	15754	15810	15864	15920	15975	16030	16086	16142
49	16197	16253	16309	16365	16421	16477	16533	16590	16646	16703
50	16759	16816	16873	16930	16987	17044	17101	17158	17216	17273
51	17331	17388	17446	17504	17562	17620	17678	17736	17794	17873
52	17911	17970	18028	18087	18116	18205	18264	18323	18382	18442
53	18500	18560	18620	18680	18739	18799	18859	18919	18980	19040
54	19100	19160	19220	19282	19342	19403	19164	19525	19586	19647
55	19708	19770	19831	19893	19954	20016	20078	20140	20202	20264
56	20326	20388	20451	20513	20576	20639	20701	20764	20827	20890
57	20953	21016	21079	21143	21206	21270	21333	21397	21461	21525
58	21589	21653	21717	21782	21816	21911	21975	22040	22104	22169
59	22234	22299	22364	22130	22495	22561	22626	22692	22758	22823
60	22889	22955	23021	23087	23153	23220	23286	23353	23419	23186

For continuation to 100 feet see Table 13.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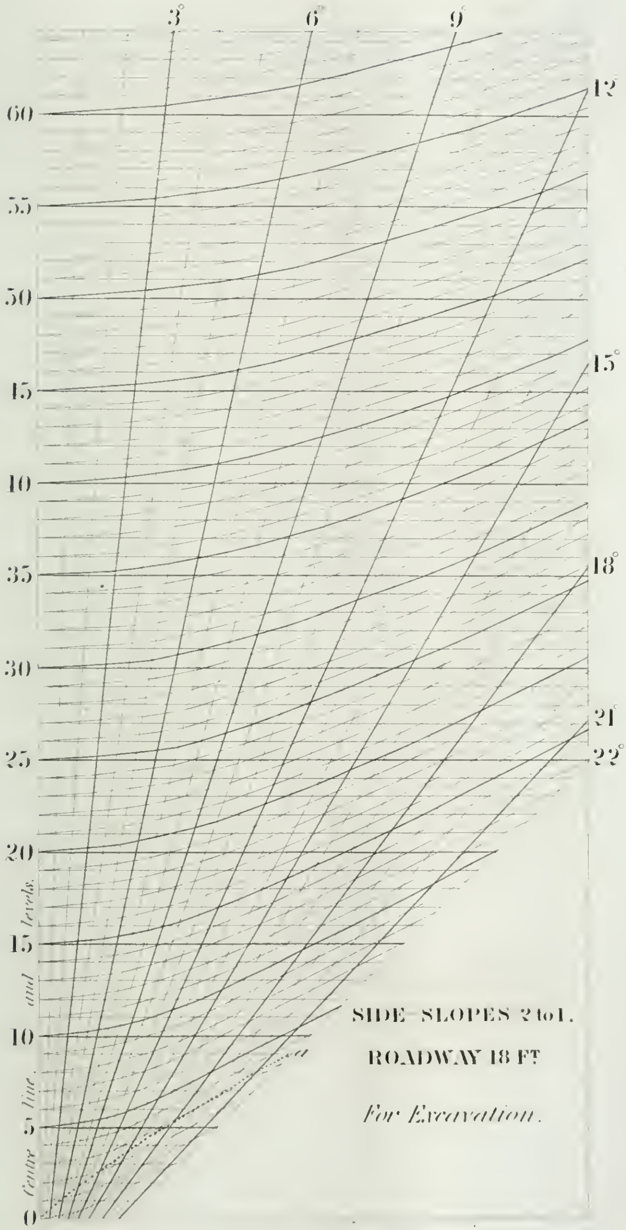
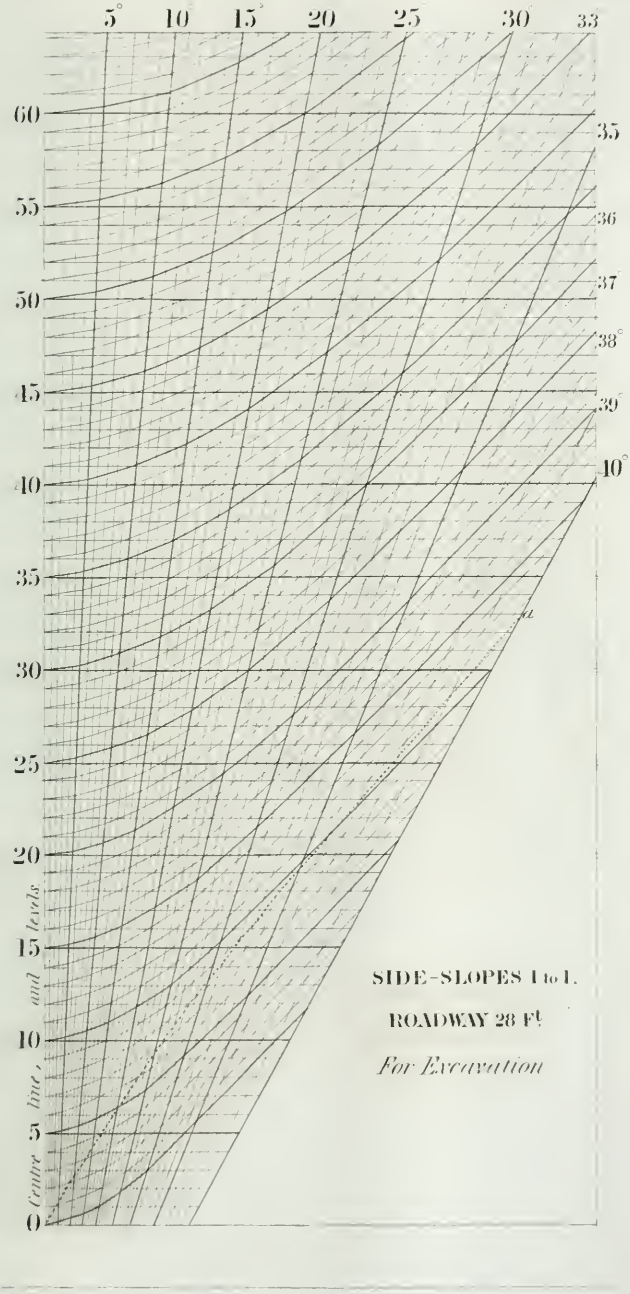
Centre line, and levels.
a
SIDE-SLOPES 1½ to 1.
ROADWAY 18 Ft.
For Excavation.



SIDE-SLOPES 2 to 1.

ROADWAY 18 FT.

For Excavation.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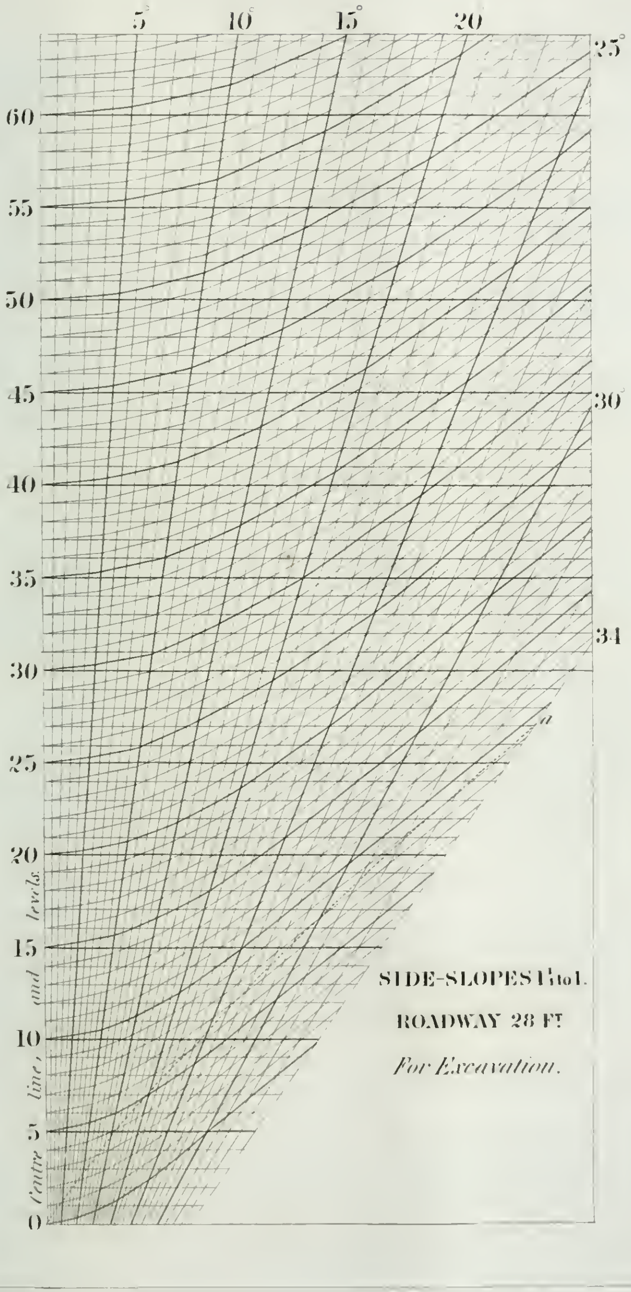
Centre line, and levels.
a
SIDE-SLOPES 1 to 1.
ROADWAY 28 Ft.
For Excavation



SIDE-SLOPES 1½ to 1.

ROADWAY 28 FT.

For Excavation.

AMERICAN PATENTS.

List of American Patents which issued from June 17, to July 8, 1851, (inclusive,) with Exemplifications by Charles M. Keller, *late Chief Examiner of Patents in the U. S. Patent Office.*

31. For an *Improvement in Brick Machines;* Mahlon Gregg, Philadelphia, Pennsylvania, June 17.

Claim.—"Having described my improvements in the machine for making bricks, what I claim therein as new is, the rotating mould-wheel, constructed as herein described, with a series of moulds in its periphery, and an annular plane outside of the moulds, and furnished with pistons, arranged as herein described, for the purpose of discharging the bricks from the moulds, as set forth.

"I also claim the mode herein described, of changing the positions of the pistons, by means of the bar attached to the horizontal presser, with its block and plate, which are made to impinge upon the vertical plates, which are attached to the pistons for that purpose.

"I also claim the combination of the hopper, horizontal presser, vertical presser, and hook rod, with the transverse horizontal lever, and with the mould wheel; the whole being constructed and arranged in the manner and for the purposes herein described."

32. For an *Improvement in the Construction of Dies;* Hiram W. Hayden, Waterbury, Connecticut, June 17.

Claim.—"I do not claim to be the first to construct a die with a lined surface, to deaden the metallic surface operated on; but what I do claim as new, and of my own invention, is the application of a die with a lined or corrugated surface, with the figure or pattern cut, or countersunk, so that the lined surface deadens the plate of polished metal, and leaves the polished surface of the figure untouched, for producing ornamental designs on polished metallic surfaces."

33. For an *Improvement in Cooking Stoves;* Elias Young, Cincinnati, Ohio, June 17.

Claim.—"Having thus described the nature of my invention, what I claim therein as new, is, the cold air passages, substantially as here arranged, to wit: having each an external aperture near their upper part on each side, beneath which projects a plate which carries the air to the centre of the stove, whence, by a second plate beneath the middle of the passage, it is again deflected to the outer ends of the passage, (thus counterbalancing the cooling effects at its entrance,) whence it is distributed in hot blasts to the fire."

34. For an *Improvement in Wash Boards;* William T. Barnes, Buffalo, New York, June 17,

Claim.—"What I claim, is, 1st, fastening cloth (or its equivalent) on the board, to prevent fine fabrics from slipping and from being torn or rubbed too much, but I do not claim lining the grooved wash board with india rubber or other equivalent material.

"2nd, I claim hinging the wash board to the frame, for the purpose of holding the clothes while being washed, and at the same time allowing the board to be turned over, subtsantially as herein set forth."

35. For an *Improvement in Augers;* Ransom Cook, of Saratoga Springs, New York, June 17.

Claim.—"What I claim as my invention, is, the form of the lips or cutting edges of boring implements, as illustrated in figures 1, 2 ,and 4, that is, such lip commencing at the screw or centre point, and running nearly at right angles thereto, until about half way from the centre to the outer part of the boring implement, when it assumes a curve upwards, or towards the handle end of the instrument, which curve is continued until it is nearly semi-circular, or until it turns within the periphery of the auger or bit, the curved edges being also under-cut or back-sloped, but without being confined to any particular angle of such back-sloping, or under-cutting: all as herein before set forth."

36. For *Improvements in Knitting Machines;* Rufus Ellis, Northampton, Massachusetts, Assignor to William M. Chase, of Boston, Massachusetts, June 17.

"The machine, as improved, is not what is usually termed, a stocking loom, but is more properly named a knitting machine, for the reason that it forms each stitch of the work in regular succession, and not a number of stitches at once, as does the stocking loom."

Claim.—"What I claim as my improvement, is the arrangement of the needles in the *plane of the endless* belt, instead of at right angles to it, in combination with the arrangement of the driving pinion, and the projecting joints of the links of the belt, *on the outside of the belt,* the belt being supported, and the whole being applied to the stitch-hook, yarn guide, and presser, and made to operate together, and with the work hanging *on the inside* of the belt, substantially as herein before specified."

37. For an *Improved Connexion of Telescopic Masts and Spars;* Charles F. Brown, Warren, Rhode Island, June 17.

"The nature of my invention consists in connecting the tubes together and adjusting them by means of a screwed rod or rods, running longitudinally through them; each rod being secured in one tube, so as to be incapable of turning, and passing through a nut or nuts in one or more of the other tubes; the whole series of tubes being adjustable, one within another, by turniug those in which are the nuts, so as to move the nuts along the screw on the rod, and each tube being capable of being secured by set screws, at various points of its length."

Claim.—"What I claim as my invention, is connecting and adjusting the several joints of masts, yards, and all spars constructed of telescopic tubes, or tubes fitting one within another, by means of a screwed rod or screwed rods, nuts, and female screws, and set screws, or their equivalents; the whole being inserted in and secured or attached to the tubes, and operating in the manner substantially as herein set forth."

38. For an *Improvement in Machines for Dressing Shingles;* Seymour Carver, Geneva, Illinois, June 17.

Claim.—"What I claim as my invention, is the arrangement of the head block, with the springs, cams, rollers, and stops, for the purpose of passing the shingles between and out from the cutting cylinders, in combination with the arrangement for depressing the upper cylinder while in motion, for the purpose of giving a taper to the shingle; the whole combined and arranged substantially as set forth in the above specification."

39. For an *Improvement in Running Gear of Locomotives;* George S. Griggs, Roxbury, Massachusetts, June 17.

Claim.—"What I claim as my invention, is the combination of the bent levers, the connexion rods, and tractile bar or spring, or other equivalent contrivance or contrivances, with the main frame (or its housings), and the boxes or pedestals of the journals of the driving wheels, and for the purpose substantially as hereinbefore specified."

40. For an *Improvement in Ventilators;* Thatcher C. Hatch, South Braintree, Massachusetts, June 17.

"My new ventilator is so arranged that from whatever quarter the wind blows, none can blow down the chimney, or whatever other orifice the ventilator may be attached to, but on the contrary, the draft is increased, while at the same time it effectually prevents all rain, &c., from entering."

Claim.—"Having thus described my improvements in ventilators, I shall state my claim as follows:

"What I claim as my invention, is a ventilator as herein above described, composed of two series or sets of curved slats, arranged one within the other, and running from the edge of the flue or other orifice, to a small circle or plate over the centre of the same; the whole forming a conical or globe-shaped ventilator, the spaces between the several outer slats being protected by the inner slats, having spaces or apertures between the two sets of slats, the only openings to said apertures being in an oblique or sideways direction—all as herein above specified and set forth."

41. For an *Improvement in Regulators for the Pen Beam in Ruling Machines;* W. O. Hickok, Harrisburg, Pennsylvania, June 17.

Claim.—"I do not claim to be the inventor of the flexible, hooked regulator, attached to the pen beam, as heretofore constructed; but what I do claim as my invention, are, 1st, I claim the pieces in combination with the hinge joints arranged and combined substantially and for the purpose as herein described.

2nd, "I claim the sliding piece, the bearings, and the finger wheel, in combination with the pieces uniting by hinge joints, or in any other manner substantially the same. using, in the construction of the whole machine, any material adapted to the purpose of forming, as herein described, a pen beam regulator, for ruling machines."

---

42. For *Improvements in Revolving Boilers;* Charles Anderson, Warren, Pennsylvania, June 17.

"My improvement consists in lining the inside of the heating surface of the boiler with wire cloth gauze, or any perforated or pervious metal work, for the purpose of gathering up the water during the motion of the boiler, and by giving a great evaporating surface, converting it quickly into steam."

Claim.—"Having thus fully described my invention, I will proceed to state what I claim as new:

" I claim lining the inside of that part of a revolving boiler which comes in contact with the fire or heat, with wire gauze, or cloth, or any perforated or pervious metal work, in the manner and for the purpose substantially as herein described."

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43. For an *Improvement in Ploughs;* John Cooper, (Administrator of Benjamin Giger, deceased,) Sangamon county, Illinois, June 24.

Claim.—" What is claimed as the invention of Benjamin Giger, and as not previously known, is the peculiar form and construction of the standard with its sockets at the upper extremity, and flanches at the lower, and the method of uniting them, so as to form a double machine, capable also of being used for cultivation in its separate parts, as set forth."

"The whole machine, as above described, constitutes "Giger's Corn Planter."

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44. For *Self-acting Guard Frog,* Charles A. Postley, Spring Garden, Pennsylvania, June 24.

"Letter *a*, surface of the ground; *b b*, the rails; *d d*, steel points to rails; *e e* are levers acting upon the guards *f*1 *f*2, and upon the upright bars or rods 3 3 3; *f*1 *f*2 guards,

Fig 1

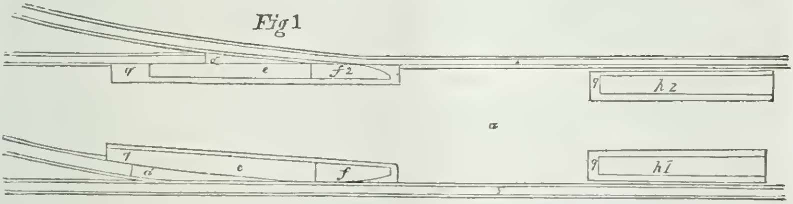
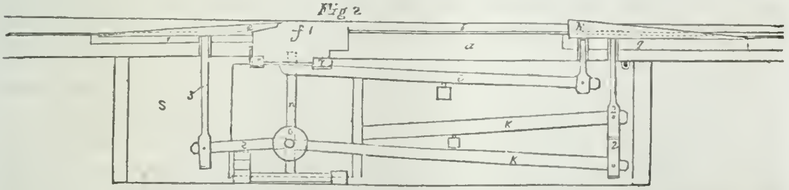


Fig 2



g g g g iron castings, forming a chamber for levers *o e* and h^1 h^2 to work in; h^1 h^2 are also levers, acting upon the upright arms or bars 1 1 and 2 2 of levers *i i* and *k k; i i*, lifting levers; *k k*, catch levers; *l l* are also catch levers; fig. 1 1, 2 2, and 3 3, in the various drawings, are upright bars or rods; *m m* are upright levers, acting directly upon and being attached to the catches *n n*, by means of the connecting rods *t t*; *n n*, vertical catches: *o o*, weight acting upon the vertical catches *n n*, by arm or rod *p*; *q*, catch in the guard; *r r*, guard lever bars, or oscillating frame; *S*, vault for the levers to work in.

"The nature of my invention consists in placing two levers h^1 h^2, inside the track, and at such a distance from the rails that the flanches of the wheels of the engine and cars shall pass freely along the road, without touching them; one end of said levers being raised higher than the rails, whilst the other is depressed, both sets of levers working upon the upright arms of levers *k k*, as fulcrums; these levers are acted upon by shifting cams or wheels attached to the locomotive."

Claim.—"What I claim as my invention, is the combination of the rising and falling guards, f^1 f^2, with the levers, *e e*, and h^1 h^2, by means of an arrangement of levers, connecting rods, etc., subtantially such as herein specified, and acting in the manner and to produce the results herein set forth."

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45. For *Improvements in Knitting Machines;* John Pepper, Assignor to Crane, Pepper, & Crane, Portsmouth, New Hampshire, June 24.

Claim.—"What I claim as my invention, 1st, is a sinker to be used in machines for knitting, so constructed as to form the loops upon the needles used in knitting two separate fabrics at the same time and at one operation; and of sufficient weight to draw the requisite quantity of yarn from the supply, to form the loops required.

"2d, Is a slur to be used in knitting machines, so constructed as to let each sinker drop to the falling bar, and draw the requisite quantity of yarn from the supply, to form the loop or loops, between the needles, before it allows the succeeding sinker to drop and act upon the yarn.

"3d, Is a falling bar, so constructed that the slurs and slur boxes traverse upon it, instead of traversing a separate bar.

"4th, Is the combination of the sinkers, stop bars, combs, and needles that traverse, so arranged as to knit two separate fabrics at the same time, with one and the same set of sinkers and slur.

"5th, I do not intend to limit myself to the precise construction described in the foregoing specification, but to use such forms of construction as will answer the purpose intended."

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46. For *Machinery for Making Wrought Iron Car Wheels;* Maria Vaughn, (Administratrix of Joseph C. Vaughn, deceased,) Greenbush, New York, June 24.

Claim.—"I claim the machinery and apparatus set forth and described, to wit: the mould, blocks or welders, the hammer or ram, with the wedges thereto attached, and the mandrel, in combination with each other, for the purpose of making wrought iron wheels, substantially as set forth in this specification."

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47 For an *Improvement in Machines for Splitting Horn and Shell;* Jabez Robins, Boston, Massachusetts, Assignor to Joel R. Morse, Leominster, Massachusetts, June 24.

Claim.—"What I claim as my invention, or improvement, is the cylindrical rotary bed or drum, in combination with the water cistern or trough, and its furnace, and machinery over the drum, for bearing the shell or material down upon it, during its revolution, as specified; the said drum being provided with a roughened or friction curved surface, such as will adhere to the shell, and cause it to move with it and against the knife as described."

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46. For an *Improvement in Printing Names of Subscribers upon Newspapers, etc.;* Henry Moeser, Pittsburgh, Pennsylvania, June 24.

Claim.—"What I claim as my invention, is the arrangement and construction of a machine for printing names of persons or places, on newspapers and other papers, after the manner substantially as described, viz: of a form containing the column of names to be printed, set up in types, and being brought under the action of a stamp, by means of a slide moving by degrees; together with the application of a slitted plate, allowing the paper (to be printed) to be pressed down on the line right beneath the slit of the plate, and shielding the paper from the lines adjoining that under action of the stamp, as hereinbefore described."

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49. For an *Improvement in Lubricating Compounds;* Jacob Selgrath, Pottsville, Pennsylvania, June 24.

Claim.—"Having thus described the mode in which my anti-attrition is compounded and used, what I claim therein as new, is the combination of ingredients herein described, whether the proportions be the same as herein set forth, or varied to any extent that the same may admit of, without changing the peculiar character of the compound as a lubricator."

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50. For an *Improvement in Cars for Transportation of Coal;* Laurence Myers, Philadelphia, Pennsylvania, June 24.

"The nature of my invention consists in one, two, or more metallic cylinders, which are adjusted in a frame, so as to be guided by it, and which cylinders have flanched rims firmly secured to them, at such points upon the cylinders as will adapt them to the width of the railroad track upon which they are to run, and upon which flanched rims the cylinder and the material contained therein revolve—the material being kept in place whilst the car is in motion, by the centrifugal force, and prevented from falling, or rolling, whilst in the act of stopping or starting, by a partition or partitions in said cylinder."

Claim.—"Having thus fully described my invention, I wish it to be distinctly understood, that I do not claim the use of cylinders for conveying material upon common roads, as this has been done heretofore; but what I do claim as of my invention, is the combination of a partition, or partitions, with a metallic cylinder, or cylinders, provided with flanched rims, as herein described, for the purpose of carrying material in bulk, on rail or other roads, where high velocities are attained, said material being held in place by centrifugal force whilst in motion, and prevented from falling or rolling in the cylinder, by the partition, or partitions, whilst in the act of stopping or starting, as herein fully described and shown, or by any other means essentially the same."

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51. For an *Improvement in Machinery for Cutting Ratian, &c.;* Sylvanus Sawyer, Templeton, Massachusetts, June 24.

Claim.—"What I claim as my invention is, 1st, the combination of the cutters, as described, with the levers, springs, and cams, or their equivalents, and also handles and links for the purpose of applying said cutters, or scrapers, so as to act upon the stick of rattan, in the manner herein described, and by which they may all be operated simultaneously, substantially in the manner herein described.

"2d, In the process of cutting cane, or rattan, into strands, as described, I claim bending the stick at the point at which the cutter is removing the strand from the surface.

"3d, I claim the combination of the elements which compose each simple section of the cutting apparatus, that is to say, of the cutter and gauge, with the stock and guide and bed roller, or their equivalents, substantially as described, for the purpose of bending the stick and removing the strand therefrom, whether said section is used alone, or is combined with others as described.

"4th, I claim the combination of that part of the machine called the scraper, with the feeding rollers, or their equivalents, and the several sections of the cutting apparatus; said sections being so arranged, in relation to each other, as that the stick, in passing from the one to the other, shall be properly bent; and also, that the several cutters shall act upon different points of its circumference; the whole being arranged and operating, substantially in the manner described and set forth."

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52. For an *Improvement in Machines for Finishing the Backs of Books;* Charles Starr, City of New York, June 24.

"I do not claim to be the inventor of 'backing books' by means of a roller, as rollers having concave peripheries have been used, which were passed longitudinally over the back. Nor do I claim the construction of the clamps or jaws between which the book is held. Nor do I claim to have invented the use of circular engraved tools, or rollers, for embossing books; but what I do claim, is, 1st, The use, for the purpose described, of a roller G, of the whole length or part of the length of the back of the book, either plain, for a plain back book, or grooved, for a raised banded book; or having a figure or figures, cut or engraved, or otherwise made upon it, rolling over the back of the book, from side to side, or from the centre to the sides, and having a yielding pressure applied to it by weighted levers, or their equivalents, in the manner substantially as described.

2nd, I claim clamping or holding the book in a swinging book holder, or its equivalent, which hangs on pivots or journals, and is capable of being swung back and forth, so as to cause the back of the book held in it, to describe an arc of a circle, and bring each part of the back to the roller, so that it shall receive an equal pressure all over its surface, substantially as and for the purposes herein set forth.

3d. The gauges sliding upon an inclined bar or bars, that they may be set to form guides for placing both ends of the back of the book at an equal or nearly equal elevation in the clamp, so as to cause each part to receive an uniform pressure, and may be drawn back from the book without dragging or rubbing the surface of the back, in the manner substantially as herein shown."

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53. For an *Improvement in making Gutta Percha Hollow Ware;* Samuel T. Armstrong, City of New York, June 24.

"My improved process is applicable to the making of all kinds of hollow articles which can be formed in moulds, such as bottles, or articles which may be made hollow, of gutta percha, or gutta percha compounded with other substances."

Claim.—"What I claim as my invention, in the process above described, is the method, substantially as described, of moulding articles of gutta percha, or the compound of gutta percha with other substances, by first making the same in the form of a pipe, and whilst in a partially heated and plastic state, giving to it the form required in a mould by forcing a liquid inside, to expand the gutta percha as described."

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54. For an *Improvement in Fastening Pedestals to Columns;* Wm. & Wm. H. Lewis, City of New York, June 24.

Claim.—"What we claim as new and of our own invention, is the application of the piece and different shaped lugs on the end of the column, to enter the hole and notches, so that on turning the column, the lugs take the inclined seats to attach the column to the pedestal, in combination with the locking piece, to prevent the column turning, substantially as described and shown."

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55. For an *Improvement in Grain Harvesters;* William H. Start, Smyrna, Delaware, June 24.

Claim.—"Having thus described my improved grain and grass cutter, what I claim as my invention, is, 1st, The standard to which the steering wheel is attached, constructed as herein described, so as to perform its own office proper, and also to adjust the cutter at the required height above the surface of the ground.

"2nd, The discharging rake, which is moved as described, in combination with the endless apron, for collecting and discharging the cut grain, as set forth."

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56. For an *Improvement in Mashing Tubs;* Joseph Wright, Waterloo, New York, June 24.

Claim.—"What I claim as my invention, is, 1st, The employment of buckets formed by the revolving arms working within the hopper, for delivering the grain through suitable openings into, and operating in combination with the mashing cylinder, having an outlet (or outlets) for supplying the cooler, substantially as shown and described.

2nd, The use of a mashing cylinder, having beaters within it, and operating in combination with a cooler, carrying any number of barrels or shafts, fitted with projecting pins, essentially as shown and described, for the purposes set forth."

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57. For an *Improvement in making Hemp from Okra;* Jean Blanc, New Orleans, Louisiana, June 24.

"The discovery which I have made consists in a new method of preparing hemp from the bark of the okra plant, by grinding or mashing the plant while in its green state, and rotting the bark in water, thereby dissolving the glutinous matter which it contains, and afterwards washing it in water before drying."

Claim.—"What I claim as my invention, is the preparing of hemp from the bark of the okra plant in its green state, and the herein described method of preparing it for use."

RE-ISSUES FOR JUNE, 1851.

1. For a *Method of Attaching Augers to their Handles;* Esther L. Larkin, Administratrix of John E. Larkin, dec'd., patented November 19, 1850; re-issued June 17, 1851.

Claim.—"What I claim as my invention, is the handle, made in two parts, one of which D, fits in a socket B, on the other A, and carries a bolt *f*, screwed at its end; the said bolt passing through a hole in the auger shank, and screwing into a female screw or nut *a*, in the part A, for the purpose of clasping, or firmly holding the auger shank between the ends of the parts A and D of the handle or stock, substantially in the manner herein described."

DESIGNS FOR JUNE, 1851.

1. For a *Design for Stove Plates;* Lyman S. Hapgood, Boston, Massachussetts, June 3.

Claim.—"What I claim as my production, is the design, consisting of the mouldings, panels, and gothic arches herein above described and represented in the drawing, for the top and front plates of a parlor stove."

2. For a *Design for Stoves;* William L. Sanderson, Troy, New York, Assignor to R. R. Finch, Peekskill, New York.

Claim.—"What I claim as new, is the border A, with its corner pieces, the figures B, C, and D; the borders E, E, E, E, and F, F, said borders and figures being of the form and situated precisely as represented and described."

3. For a *Design for Stoves;* Samuel W. Gibbs, Assignor to Jagger, Treadwell, and Perry, Albany, New York, June 10.

Claim.—"What I claim as my production, is the combination and arrangement of ornamental forms and figures represented in the annexed drawings, forming the ornamental designs for front and side plates of a cooking stove, with the doors thereto belonging."

4. For a *Design for Stoves;* W. G. Hallman, Philadelphia, Pennsylvania, June 10.

Claim.—"Having thus fully described my design, what I claim therein is the design or ornamental pattern herein fully set forth and delineated."

5. For a *Design for Stoves;* A. Cox, Elias Johnson, and D. B. Cox, Troy, New York, June 10.

Claim.—"Having thus fully described our ornamental designs, what we claim, is the ornamental design stove pattern above described, formed of flat ribbons, as fully illustrated."

6. For a *Design for Stoves;* A. Cox, Elias Johnson, and D. B. Cox, Troy, New York, June 10.

Claim.—"Having thus fully described our improved design, what we claim, is the within described and illustrated ornamental design stove pattern."

7. For a *Design for Stoves;* John F. Rathbone, Albany, New York, June 10.

Claim.—"What I claim as my production, is the combination and arrangement of ornamental figures and forms represented in the accompanying drawings, forming together an ornamental design for a six plate stove."

8. For a *Design for Stoves;* David Stuart, and Jacob Beesley, Assignors to W. P. Cresson, Philadelphia, Pennsylvania, June 10.

Claim.—"We have thus detailed the particular ornamental designs on the respective plates which we wish to patent, and do hereby claim the exclusive right to the said ornamental designs for stove plates, as we have laid them out and displayed them."

9. For a *Design for Stoves;* Joseph G. Lamb, Cincinnati, Ohio. June 17.

Claim.—"Having thus fully described and shown the aforesaid design, what I claim as my invention, is the combination and arrangement of the above described and represented shapes, mouldings, and ornaments, substantially as herein shown."

10. For a *Design for Stoves;* Joseph G. Lamb, Cincinnati, Ohio, June 17.

Claim.—"Having thus fully described the various parts of the above named ornamental design, what I claim as new, and my invention, is the combination and arrangement of the herein represented shapes, ornaments, mouldings, and figures when combined and arranged substantially as shown."

11. For a *Design for Stoves;* Samuel A. House, Mechanicville, New York, June 24.

Claim.—"What I claim as new, is the design and configuration of box-stoves, substantially the same as herein described and represented."

JULY.

1. For a *Vice Saw-Set;* William Hinds, Otsego, New York, July 1.

Claim.—"What I claim as my invention, is constructing a vice for the purpose of compressing saws, to be set or filed, in the following manner, namely: with only one supporting arm to each jaw, hinged at their lower extremities, and having an extra arm on one side of, and parallel or nearly so, to said supporting arms, to the upper extremity of which is attached an eccentric lever, or its mechanical equivalent, for compressing the two jaws together; constructed substantially as herein described."

2. For *Arrangement of Catches on the Upper Sash, operated by moving the Lower Sash;* Washburn Race, Seneca Falls, New York, July 1.

"The nature of my invention consists in constructing and arranging the catches which hold up the upper sash of a window, in such manner that they can be operated to release the upper sash, and allow it to open, or to secure this sash in any desired position, either opened or closed, by means of the lower sash of the window, and without applying the hands either to the upper sash, or to its catches."

Claim.—"What I claim as my invention, is the arrangement herein described, of the catches and window sashes for the purpose described."

3. For an *Improvement in Boxes and Axles for Saving Oil;* Benjamin Kraft, Reading, Pennsylvania, July 1.

Claim.—"I claim causing the bevelled edges of the oil box to enter the grooves of the axle, and rest against their *outer* shoulders, but not against their inner shoulders; thus, at the same time, preventing end play and the escape of the oil, the journal bearing being lower than the bevelled edges of the oil box, and sufficiently above the bottom of it to prevent the oil coming from the box to the journal."

4. For an *Improvement in Inkstands;* Henry Whitney, jr., Cambridge, Massachussetts, July 1.

Claim.—"I do not claim the invention of the elastic diaphragm for inkstands, but I claim my inkstand as a new article of manufacture, in which the following features are, for the first time, associated, viz: an elastic diaphragm covered and secured from injury, by a metallic cap, and regulated by a screw passing through the cap, and in combination with the diaphragm, the funnels top, and waste cup."

5. For an *Improvement in Iron Fences;* John B. Wickersham, of the City of New York, July 1.

Claim.—"Having thus fully described the nature of my invention, and the manner of constructing the same, what I claim therein as new, is the manner herein described of securing the rails of iron fences, by means of sectional or divided parts, having slots therein, which are so arranged, that when in place they break joint with each other, the slot in one section extending upward, and the slot in the other downward, so closing the slots as to prevent the rails, which have a loop or dead eye turned on each end for that purpose, from passing through, or coming out, as herein fully set forth."

6. For an *Improvement in Bedsteads;* Harvey W. Sabin, Canandaigua, New York, July 1.

"The nature of my invention consists in providing the means of holding a bedstead together, and at the same time furnishing an elastic bottom."

Claim.—"What I claim as my invention, is the knuckle joints for holding the rails of the bedstead together, in combination with the rods, substantially in the manner and for the purpose described, said rods being also employed to support the slats forming the bottom of the bedstead."

7. For an *Improvement in Spectacle Frames;* John P. Paine, Worcester, Massachussetts, July 1.

"The nature of my invention consists in so combining a steel spring with the joint and temple of the frame, as to secure ease to the wearer, and safety to the frame."

Claim.—"What I claim as my invention, is the combination of the spring and cylinder with the temple bow and the glass frame, the whole being substantially as specified."

8. For an *Improvement in Grain Harvesters;* Aaron Palmer and S. G. Williams, Brockport, New York, July 1.

Claim.—"What we claim as our invention, is the discharging the cut stalks and heads of grain from the platform, by means of the combination of the rake with the lever, and the co-operation therewith of the series of teeth on the face of the wheel and the inclined rail rising above the curved guard of the platform, substantially in the manner herein set forth."

9. For an *Improvement in Bread Cutters;* Almon E. and Davenport Lazell, of Chickopee Falls, Massachussetts, July 1.

"Our improvement consists in fitting a set of knives, each made in the form of an eccentric circle, to an arbor, and having them work in guides, and with holders in such a manner, that by causing them to revolve by means of a crank, (or otherwise,) a whole loaf may be cut into suitable slices, at every revolution, without breaking or crushing the bread."

Claim.—"What we claim as our invention, is the use of a series of knives or cutters made in the form of eccentric circles, or scrolls, with the cutting edge on the periphery, so as to represent a spiral line, or curve, when combined with the bars or ribs of the bed piece, which serve to sustain the loaf, and also to guide the knives, and with the fingers or prongs, which hold the loaf against the knives whilst cutting, and also act as outside guides, when the whole is constructed, arranged, combined, and operating substantially as herein described."

10. For an *Improvement in Piano Fortes;* Michael Miller, Rochester, New York, July 1.

Claim.—"What I claim as my invention, is the spring acting on the valve at D, in combination with the weight of the key, resting on the valve at E, for the purposes substantially as herein described and represented."

11. For an *Improvement in Machines for Making Hat Bodies;* Daniel Barnum, County of Philadelphia, Pennsylvania, July 1.

"I will illustrate the nature of my invention by remarking, that long experience has proved the small wire picker which is universally used in the common fur blower, to be the best means, or instrument, for opening the fibres of fur, and that the arrangement of the common fur blower consists of a feeding apron, feeding rollers, and a picker with numerous small wire teeth placed within a chamber having an aperture under the picker, for the admission of a current of air, to aid in throwing the fibres into the chamber."

Claim.—"Having thus fully described my inventions, and pointed out some of the modes in which I contemplate using them, and having referred to what was previously known in this branch of the arts, in order that my invention may be the better understood, I do hereby declare, that I do not claim the combination of a picker and chamber, having an aperture for the admission of air, such a combination having long been used for cleaning the fibres of fur. Nor do I claim the combination of these with a perforated exhausted former, such a combination having been described and referred to, as applicable to forming hats and other irregular forms, in an application for a patent, by T. R. Williams in 1840,* though it was not then claimed as invention. Nor do I claim the use of water to harden or to wet the hat body; such use being as old as the felting process, and is indispensably necessary in all hardening and felt process. Nor do I claim the hardening of a hat body on a cone; such a process having been described and patented to Wells, James, and Peck, 1837,† they using a solid cone, upon which a web was wound, to form the body, and numerous jets of steam were used to harden the same, or to wet it, as it was wound on the cone, there being no exhaust; and processes for hardening bodies on a perforated cone have also been described in 1840, by Williams and by Wells in 1846,‡ they both using water pressure to hold the fibres, while the cone and fibres are immersed. Nor do I claim any of the parts as my invention, except as they are used in new combinations and producing new and important resutts.

"But what I do claim as my invention, is the exhausting and suspending fan, with its casing and aperture, constructed, arranged, and operated, substantially as and for the purposes herein before particularly described, in combination with the picker, chamber, perforated exhausted former, and exhaust fan, arranged substantially as described and shown, by which arrangements and combinations, the several parts or their equivalents, perform their several and combined functions in a better manner, and produce better results, than has been heretofore attained, without any chamber, trunk, or tunnel, or any other means, to control the fibres, after being suspended in the air by the fan or between the fan and perforated exhausted cone or former, substantially as described and shown.

"I also claim the combined action of the currents of air, and the currents of numerous jets of hot water, in the hardening or wetting process, the currents of air performing the triple duty of holding the fibres on the former, and of aiding the water to penetrate the hat body, and, at the same time, to carry the surplus water through the perforations into the exhaust, thus effectually preventing injury to the hat body, from the accumulation of the surplus water, to wash it, while the wetting or hardening process is greatly facilitated, and the perfection of the work is secured, the whole process being accomplished by the combination of the several parts named, or their equivalents, for producing the currents of air and water, with the perforated former over the exhaust, in the manner and for the purposes substantially as herein described and shown.

"The effect of these improvements, is the production of a machine, combining the best means for opening fibrous materials and suspending them in the air, surrounding a perforated and exhausted former, and also of a new combination of means for hardening the fibres and completing the process, without removing the hat, or applying any pressure preparatory to the suspension of the pressure of the air, by which means, a great improvement is effected, as well in the forming of the hat, and in the process of hardening, as in the facility of operation. The whole being by combination of machinery heretofore unknown."

12. For an *Improvement in Lathes;* Thomas R. Bailey, Lockport, New York, July 1.

Claim.—"What I claim as my invention is, controlling the poppet centre, so that it releases itself after the turning is finished, by connecting it with a sliding bar, having a weight or its equivalent attached, and carrying a ratchet, which is held by a ratchet attached to the stationary bed, the said catch having an arm attached, which is struck by part of the cutter head, after the cut is finished, and released from the ratchet, substantially as herein shown."

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* See Journ. Frank. Inst. Vol. III, 2d Series, page 132.

† See Journ. Frank. Inst. Vol. XXII, 2d Series, page 41.

‡ See Journ. Frank. Inst. Vol. III, 3d Series, page 323.

13. For an *Improvement in Running Gear of Railroad Carriages;* Daniel W. Eames, West Turin, New York, July 1.

"The nature of my invention consists in attaching to the trucks or vehicles, any number of duplicate inclined wheels, resting upon opposite sides of the same rail, whereby the moving vehicles are, in a manner, tied to the rail, so that curves may be more easily traveled; also, not necessarily causing any deviation from the course, by breakage, or removal of one line of rail."

Claim.—"What I claim as my invention, is the employment of wheels in any number of pairs, attached, on either side, to the track or frame of railway vehicles, and set at any inclination to the horizon, converging to a point in or below the rail, so that both wheels of any one pair will rest or travel on opposite sides of the upper surface of either one or the same rail, essentially as shown and described."

14. For an *Improvement in Wire Hooks and Eyes;* Charles Atwood, Derby, Connecticut, July 1.

Claim.—"What I claim as my invention, is, 1st, The addition of side springs to the common forms of hooks and eyes, substantially in the manner and for the purposes set forth.

2d, "I claim the small ridges or elevations on each side of the break of the hook, made by bending the wire of the side springs, or by other means equivalent thereto, for the purposes set forth.

3d, "I claim the jews-harp form, or partly circular eyelets, extended, to form loops, adapted to receive tape, in connexion with the small elevations to keep the tape in its proper place, substantially as set forth."

15. For *Improvements in Machinery for Cutting Files;* John Crum, Ramapo, New York, July 1.

Claim.—"What I claim as my invention, is connecting the file blank to be cut, with a bed which has a positive feed motion, substantially as described, in combination with an incidental rolling motion, depending upon the shape of the blank, and the angle which the cutter forms therewith, substantially as described.

"I also claim connecting the chisel with its stock, by a joint, as described, in combination with a rolling bed as described, by which they are rendered self-adapting, as described.

"I also claim holding the file down on the bed during the operation of cutting, and near to the cutter, by means of a roller or its equivalent, combined with the rolling bed, substantially as herein described; but this I only claim when the end of the file is so connected with its bed, that it shall be free to move up and down, that the pressure of the roller may keep that part of the file that is being cut, firmly down on to the bed, as herein specified.

"I am aware that before the date of my invention, the cutter of file cutting machines has been jointed to a helve or bar; but in such cases it has not been combined with a rolling bed, and therefore, I do not wish to be understood as claiming broadly, the making of the cutter with a joint; but to claim this only under the limitations pointed out above.

"I am also aware that the file blank has been made to slide during the feeding motion, over a rolling bed, to adapt the transverse plane of the file blank to the line of the cutting edge, for cutting the different ranges of teeth, and, therefore, I do not wish to be understood as claiming broadly, the employment of a rolling bed, but to claim such rolling bed when made to move with the file, during the feed motion, from end to end, under the limitations above specified."

16. For an *Improvement in Handles of Brushes and Brooms;* Luke F. Cavanaugh, Newfield, New York, July 1.

Claim.—"Having thus described my improvements, what I claim as new therein, is the lever jaws, held together by the head piece of the screw in combination with the conical end of the handle, substantially in the manner and for the purpose set forth."

17. For an *Improved Arrangement of the Steam Engine;* Frederick P. Dimpfel, City of New York, July 1.

Claim.—"What I claim as my invention, is the method herein described, of connecting the steam piston of a steam engine, with the crank thereof, by means of a piston rod, fixed cross head, side bars, forked connecting rod, and belts, or the equivalents thereof, these several devices being arranged and operating substantially as herein set forth, in such manner that the cross piece of the connecting rod, which is placed transversely to the crank shaft, shall be on opposite sides of the axial line of said shaft, at opposite extremities of the stroke of the piston.

"I also claim the belts or gimbal-rings, or the equivalents thereof, arranged substantially as herein set forth, for the purpose of transmitting the movement of the cross head to the connecting rod of a steam engine."

18. For an *Improved Mode of Papering Pins;* Chauncy O. Crosby, New Haven, Connecticut, July 8.

Claim.—"What I claim, therefore, as my invention is, the producing of a new manufacture of "pin rolls," either oblong, oval, cylindrical, square, or other shape or form, (so that it combines, in effect, the common sheeted pin paper or fillet, stuck, or inserted pin paper, or pins wound in closely between the layers, laps, or folds of fillet paper, with the common pin cushion,) whether the centre of the cushion is elevated or plane; that is, whether coned up or level, or whether the pins are inserted through crimps or not, and embraced by the fillet paper. The fillet embracing the shank or barrels of the pins, while the heads of the pins are not so embraced, but open and conveniently accessible to be withdrawn for use, without unfolding, unwinding, or disturbing the pin roll, substantially as herein described by the specification and drawings."

19. For an *Improved Portable Hydraulic Press;* Richard Dudgeon, City of New York, July 8.

Claim.—"What I claim as my invention is, an hydraulic press, quite portable, in which the ram is hollow, and serves as the reservoir, to supply the cylinder with water, or other liquid, while the force-pump and its appendages are contained within the ram; so that by working this force-pump, the ram is forced up, until the liquid in such ram is exhausted, and by moving the handle of the pump down, it will come in contact with a rod attached to a valve in the pump piston, and the latter comes in contact with a valve in the end of the ram, opening them both, and allowing the water to return into the ram again, through passages."

20. For an *Improved Mechanical Hooker-Up;* David J. Happersett, Downingtown, Pennsylvania, July 8.

Claim.—"What I claim as my invention is, in combination with a plate, or the equivalent thereof, for receiving the mass issuing from a rolling mill, the friction drums, the periphery of one of which is shaped substantially as described, and operating substantially as herein set forth, in such manner, that by their action, the plate, or its equivalent, is quickly raised and held stationary at the proper height, to permit the mass upon it to be passed to the front side of the mill, and is rapidly lowered to the proper position, to receive the mass issuing from the rolls."

21. For an *Improvement in Silk Covered Buttons;* Hirsch Heinemann, City of New York, July 8.

Claim.—"I do not mean to limit myself to the shape of the mould, nor to the pattern or color formed on the silk covering; neither do I claim to be the first who has used the split shank, plate, and washer, as that has been used with a glass bead for ornamental purposes; but I do not know of any one who has used this plate, shank, and washer, as the means for fastening a silk covered button, and at the same time, secure and hide the ends of the silk cover in the hole of the mould, thereby making a durable, finished, and handsome ornamental button.

"Therefore, what I claim is the application of the plate, shank, and washer, to a silk covered button, for the purposes specified and as described and shown."

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22. For an *Improvement in Machines for Grooving Lumber;* Birdsill Holly and John W. Wheeler, Seneca Falls, New York, July 8.

Claim.—"Having thus fully described our improvements, what we claim to have invented is, the method herein described, of forming grooves by circular saws and a deflecting throat, in combination with suitable cutters, as set forth."

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23. For an *Improvement in Harvesting Machines;* William Jones, Bradford, Vermont, July 8.

Claim.—"Having thus fully described the construction and operation of my grain harvester, what I claim therein is, the use of rotating cutters, in connexion with the rotating rake and teeth, operating substantially as described.

"I also claim the novel manner of gearing the horses, or animal power, under the machine, so as to conduct the grain over them, and discharge it in a straight line, in the wake of the machine, substantially as herein described and made known."

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24. For an *Improvement in Cork Cutting Machines;* William King, City of New York, July 8.

"The nature of my invention consists in such construction of a machine for giving the cylindrical form to the bottle corks, as will enable the workmen readily to adjust it, while actually cutting, to cut a perfectly formed cork of the largest size the "square" will admit. In all machines for this purpose, hitherto in use, the corks are cut to an uniform size; but in practice this is not found to be desirable, as from the peculiar nature of the material, it is difficult to provide "squares" of uniform size, and hence, where the machine must be set to cut a perfectly formed cork from "squares" of the smallest size, a loss of stock results on all others."

Claim.—"I do not confine myself, strictly, to the precise form of construction herein described, but claim to vary the same as desirable, while I produce the like results by equivalent mechanical means. What I claim as of my own invention is, the lifting block, susceptible of such adjustment, with reference to the edge of the knife, while the machine is in motion, that from squares of varying sizes perfectly formed corks may be cut, of the largest size each square will afford, the whole being constructed and operating substantially in the manner herein set forth."

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25. For an *Improvement in Seeding Machines;* Samuel Pennock and Morton Pennock, Kennet Square, Pennsylvania, July 8.

Claim.—"Having thus fully described the construction, use, and operation of our several improvements on the seeding machine, what we claim therein as new is, 1st, we claim the employment of the oblique, recessed washer, in combination with the cylindrical cap, provided with inclined wings or projections, which match with the oblique recesses of the washer, in such a manner that the pressure produced thereupon, shall securely hold the cylindrical cap in the required position, when adjusted to increase or diminish the size of the seed receptacles.

"2d, We claim scolloping the end of the cylindrical cap of the distributing cylinder, and using in connexion therewith clamp screws, for holding the cylindrical cap in the required position.

"3d, We claim the employment of the pin, or its equivalent, when used in connexion with a clamp screw, and interior cylindrical cap, when properly adjusted, to increase or diminish the size of the seed receptacles.

"4th, We likewise claim providing one of the journal pins of each depositing tube with a cog, which is made to fit an opening in the arm of the drag bar, when it shall be turned frontward, nearly horizontal, for the purpose of detaching the depositing tube from the drag bar with facility, as described and shown in Fig. 18.

"5th, We further claim the employment of the trifurcated holding lever, in combination with the drag bar, and suspended depositing tube, for the purpose of holding the depositing tube in its proper position, during the operation of forming the drill and depositing the seed, and by which said trifurcated holding lever may be disengaged from the pin when an obstruction is visible, and allow the depositing tube to turn rearward when it shall have been struck, and thus save the pin from being broken; and this trifurcated holding lever we claim, or its equivalent.

"6th, We likewise claim causing the depositing tube to assume its proper position, after it shall have cleared the obstruction, by the action of the long arm of the trifurcated holding lever upon the cam or projection of the depositing tube; and this we claim as in the arrangement herein described and represented.

"7th, Lastly, we claim so combining a separate double arm with the frontward end of each drag bar, that it may be detached therefrom, as well as from the eyes or loops of the front transverse beam of the frame, as described in the specification."

26. For an *Improvement in Revolving Breech Fire Arms;* Parry W. Porter, Memphis, Tennessee, July 8.

Claim.—"Having thus described my self-loading, repeating fire arm, what I claim as my invention is, 1st, in combination with a cocking lever, I claim the two triggers arranged and operating in such manner, that the tripping of the hammer can be effected either in the ordinary manner, by pulling a trigger, or by the return movement of the cocking lever.

"2d, I claim the combination of the sliding bolt with the cap primer, the two being so arranged, that as the hammer is tripped by pulling the trigger, a cap is applied to one of the nipples of the chambered breech, by which means the chambers are revolved by the back motion of the cock, and capped by its forward motion; the capping by this arrangement being effected in one half the time in which it can be done by others heretofore devised.

"3d, I claim the construction of the cap and bullet passages, the powder magazine, and the exterior case, in such manner that the bullet and cap passages, and the included powder chamber, can be withdrawn from the exterior case which encloses them, to give free access to every part of said passages, and to facilitate the removal of obstructions therefrom, as described.

"4th, In combination with a revolving disk breech, I claim a spring powder charger, constructed and operated by the movement of the breech, as herein set forth.

"5th, In combination with a revolving chambered breech, I claim the stationary cap stripper, constructed and operating as herein set forth.

"6th, In combination with a revolving breech fire arm, I claim the spring dust-plate, which permits the escape of smoke, but prevents the entrance of dirt.

"7th, I claim the forward inclination of the spout of the bullet passage, in connexion with a turning breech, the two being so arranged that when the latter is turning, the bullet dropped into the chamber is pressed against the inclined portion of the spout, and is by it forced down in the chamber of the breech, the inclined surface of the spout thus performing the office of a rammer."

27. For an *Improved Apparatus for Punching Designs in Sheet Metal;* William T. Rudd, Amsterdam, Virginia, July 8.

Claim.—"What I claim as my invention, is the leather bed or die, in combination with a set of punches for puncturing purposes, when such set of punches and the die are used in connexion with proper rollers, substantially in the manner and for the purposes herein set forth."

28. For an *Improvement in Rakes to Harvesting Machines;* William H. Seymour, Brockport, New York, July 8.

"My improvements consist in a new arrangement for raking the grain from the machine; also, in the peculiar manner of constructing, arranging, and supporting the bearings of the gear shafts, by which the gearing is made more compact and convenient than it otherwise could be, which parts will be particularly described."

Claim.—"What I claim as my invention, is the rake attached for raking the grain from the machine, without hand labor, constructed and operated substantially as described."

29. For an *Improvement in Machines for Pressing Hats;* John Stearns, Templeton, Massachusetts, July 8.

Claim.—"What I claim as my invention, is the method of alternately lowering the pressing irons upon the hat block, and raising them therefrom, by mechanism, operating substantially as herein described, which is readily controlled by the attendant."

30. For an *Improvement in Lifting Jacks;* James St. John, City of New York, July 8.

Claim.—"What I claim as my invention, is the catch or button operated by the index bar, for the purpose of directing the action of the lever, substantially in the manner herein set forth."

MECHANICS, PHYSICS, AND CHEMISTRY.

For the Journal of the Franklin Institute.

Demonstration of Foucault's Experiment. *By* Charles J. Allen.

In the demonstration of Foucault's experiment, published in the last number of the Journal, in stating the conclusion that the ball of the pendulum has (irrespective of the vibration) the same absolute motion as the several parts of the circle F H G, I omitted to show that the motion of any and every point in this circle is the same *in direction* as that of the centre B. The object of the present communication is to supply this omission. The defect was not observed in time to remedy it satisfactorily in my former article.

Fig. 1.

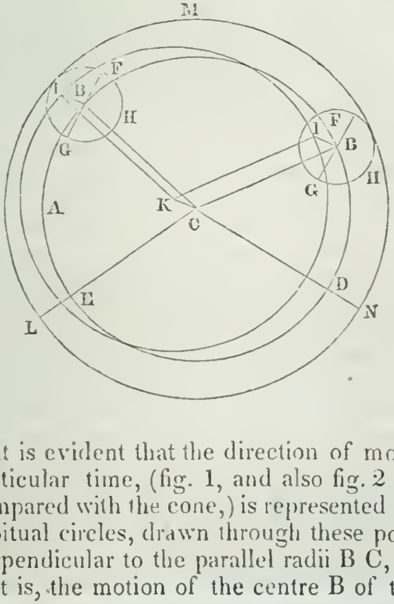
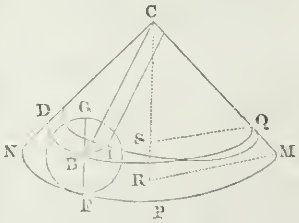


Fig. 2.



It is evident that the direction of motion of the points B and I at any particular time, (fig. 1, and also fig. 2 if F H G be supposed very small compared with the cone,) is represented by the tangents of their respective orbitual circles, drawn through these points; and since these tangents are perpendicular to the parallel radii B C, I K, they are themselves parallel; that is, the motion of the centre B of the circle F H G and that of any point whatever in this circle are constantly parallel to each other; in other words, the several parts of the circle F H G are moving absolutely in the same direction. The same thing may be proved by joining B B, any two positions of the point B, and also I I, the corresponding positions of the point I; then these lines, since they join equal and parallel lines towards the same parts, are themselves equal and parallel; that is to say, the chords of the equal arcs described by the points B and I in the same time, are not only equal, but also parallel, and this is the case, however great or however small these arcs may be; but when these arcs are infinitely small, these chords coincide with their respective arcs—from which it follows, that the circumference of the circle of orbitual motion passing through I, has, *at the point I*, precisely the same direction that the circumference of the circle A B D E passing through the centre B has *at the point B;* which is, in effect, the same conclusion as that arrived at by the first method. There may, at first sight, be an apparent absurdity in this, inasmuch as the two circles of orbitual motion *cut* each other; but a little reflection will show that this absurdity is only apparent.

At the time my first article was sent to the editor of the Journal, I had seen no attempt at a regular and rigid demonstration of the new and interesting experiment. Subsequently, however, I have met with several articles in which the idea of the "*cone of latitude*," as J. R. Young appropriately terms it, is more or less fully developed. Though indebted to no one for the employment of this means of simplifying the problem, it appears that the idea of the tangential cone had suggested itself to one or more other individuals before it had occurred to me.

Before leaving the subject, it may be well to observe that the denominator of the fraction in the formulas given on page 42 of last number, varies slightly with the latitude of the place—that there given (77787) being calculated for the latitude of 45°. A better form of the general expression for the value of y is the following, which is true for any latitude, s being the length (in feet or in the same denomination as l) of a pendulum beating seconds at the given place, viz:

$$y = \frac{r \text{ sin. L cos. } a}{43082} \times \sqrt{\frac{l}{s}}$$

Philadelphia, 7th mo., 9th, 1851.

On the Velocity of Light.—Experimental Proof of the Theory of Undulation. By John Tyndall, *Ph. D., Marburg.* *

1. *Méthode générale pour mesurer la vitesse de la lumière dans l'air et les milieux transparents,* by M. L. Foucault. *Comptes Rendus,* May 6, 1850.
2. *Sur la Vitesse comparative de la lumière dans l'air et dans l'eau,* by MM. H. Fizeau and L. Breguet. *Ibid.* June 17, 1850.

The state of Arago's sight has recently induced him to resign the carrying out of his proposition of submitting the two rival theories of light to experimental decision to physicists gifted with younger eyes. It is well known, that, according to the theory of Newton—the so called *emission theory*—the velocity of light in passing from a rarer medium into a denser is *increased*. For example, the index of refraction in passing from air to water is $\frac{4}{3}$; according to the emission theory, the velocity of light in air is to its velocity in water as 3 is to 4. Opposed to this stands the theory of undulation, proposed by Huyghens, and supported by Euler, Young, and Fresnel. According to this theory, the velocity of light in passing from a rarer to a denser medium is *diminished;* in the case of air and water, for instance, the above ratio is reversed; the velocity of light in air is to its velocity in water, in the ratio of 4 : 3. The genius of Fresnel has won for the latter theory almost universal recognition; a direct proof was however wanting, and this urged Arago* to the hardy thought of submitting the question to an experimental test.

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* From the London, Edinburgh, and Dublin Philosophical Magazine, for June, 1851.

The rotating mirror of Mr. Wheatstone was proposed as the instrumental agent for carrying out this idea. If we conceive a ray of light to enter a dark room through a hole in a window-shutter, and to fall upon the plane surface of a reflecting mirror set perpendicular to the direction of the light, the latter will be sent back along the path by which it entered. If the reflecting surface be oblique to the direction of the light, the latter will be reflected in some other direction; supposing a second reflecting mirror to be set perpendicular to this latter direction, the light will be reflected from this in the direction of the perpendicular, will again strike the other mirror, and be finally sent back by the latter through the aperture by which it entered. In this case the ray suffers two reflexions from the intermediate mirror; and if it be true that light requires time in passing from one point to another, these two reflexions *cannot occur contemporaneously*. A certain portion of time, however small, will be required for the journey to and fro from one mirror to the other. Supposing, for instance, the mirrors to be placed six feet apart; the light proceeding from the aperture is received upon the first mirror and reflected by it on to the other; from this it is reflected back again, and thus accomplishes a journey of twelve feet between its two reflexions by the first mirror. To this journey, as has been said, time is necessary. If the aperture and the two mirrors be perfectly motionless, the path of the light in coming, will coincide with its path in returning; but if, while on its route *between the two mirrors*, we conceive the position of the first mirror to be changed, that, for instance, it has become more inclined to the direction of the ray, the latter will not be reflected in the line of its approach, but will be thrown against the window shutter more or less to the side of the aperture. This change in the position of the mirror during the almost infinitesimal portion of time occupied by the light on its twelve feet journey, is accomplished by imparting to the mirror a high angular velocity, say a thousand revolutions in a second. We here find ourselves in possession of a means of comparing the velocity of light in air with its velocity in water. When the mirror rotates, the ray sent back does not strike upon the aperture, but more or less to the side of it. The less time occupied by the light in performing its double journey between the two mirrors, the less ought this divergence to be, and *vice versa.* Hence, if the Newtonian theory be true, the introduction of a column of water six feet long ought to bring the reflected image of the aperture *nearer* to the aperture itself; and if the undulation theory be true, the introduction of such a column ought to make the divergence *greater.* These speculations have been recently submitted to the test of experiment, and the result has pronounced in favor of the theory of undulation.

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* It ought to be mentioned, that the same subject had occupied the attention of Sir John Herschel and Mr. Wheatstone some years before it was mooted by Arago; and a proposition was actually made by the former to send a bar of light through a tube of water or alcohol a mile in length, and thus determine the influence of this medium. This idea, though not so practical, is the same in principle as that of Arago. The latter, however, was not aware that any such proposition had ever been made.

Of course, such experiments, though easily described and simple enough in principle, demand considerable delicacy of manipulation. The divergence spoken of is in reality exceedingly small. In order to observe it, M. Foucault has made use of a square aperture furnished with a number of vertical bars of fine platinum wire; eleven of these fitted in the space of one millimetre, and between each two there was a small space through which the light entered. The image given by this was a small field furrowed with alternate black and white stripes. The light after entering through this aperture fell upon a lens, by which it was converged, but before it came to a focus on the opposite side it fell upon the rotating mirror; it was thence cast upon a concave mirror placed about six feet distant, which reflected it back again. By a peculiar artifice, M. Foucault was enabled to compare with great nicety the divergence of the black and white stripes in the image from the platinum wires and their intervening spaces. "I have already proved," says M. Foucault, "by two successive operations, *that the deviation of the image after the journey of the light through air is less than after its journey through water.* I have also made another confirmatory experiment, which consists in observing an image formed partly by light which has passed through air, and partly by light which has passed through water. For small velocities, the stripes of this mixed image were apparently continuations of each other. *But by the acceleration of the motion the image is transported, and the stripes are broken at the point of junction of the air image with the water image. The stripes of the latter take the advance in the sense of the general deviation. Further, on taking into account the length of water and of air traversed, the deviations are found to be proportional to the indices of refraction.* These results indicate a velocity of the light *which is less in water than in air*, and, according to the views of M. Arago, fully establish the theory of undulation."

The following interesting article on the same subject is from MM. Fizeau and Breguet.

We have realized with great exactitude, the experiment described in our note presented to the Academy during its session of the 6th of May last; an experiment which we felt called upon to make, although M. Foucault in the same session had read an extended paper upon this subject, in which he announces that he has already obtained decisive results.

We have thought that, for the solution of a capital question like the present, the proofs could not be too much multiplied, and that experiments made under different circumstances could not but contribute to render our knowledge of an important fact more certain.

We have applied ourselves to the solution of the question as proposed by M. Arago in 1848; that is to say, How can the two opposite theories regarding the nature of light be submitted to a definite test? We have adopted such measures as are calculated to exhibit in a striking manner the differences of the phenomena as deduced from the one or the other theory.

As remarked in our preceding communication, the observation was made simultaneously on two bundles of light; the one having traversed the air, the other a column of water.

For each of these bundles the path was as follows:—A telescope was so disposed that its object glass was very near the rotating mirror; a little rectangular prism was placed in the focus of the telescope, in such a position that the solar rays falling upon it from a convenient lateral opening near the eye-glass, were totally reflected towards the object-glass.

Beyond the rotating mirror, and at a distance which for the ray that passed through water amounted to two metres, there was a fixed reflector designed to send back the light to the rotating mirror by a normal reflexion.

The focal distance of the telescope was such that the image of the little prism placed at its focus formed itself distinctly upon the fixed reflector just mentioned. After having been reflected from it, the light returned to the rotating mirror, was sent on through the telescope, and on passing the focus formed an image which exactly covered the prism.

By the rotation of the mirror we give birth to a number of images which succeed each other very rapidly, and the super-position of which produces the sensation of a permanent image.

When the rotation became sufficiently rapid, the permanent image was pushed forward in the direction of rotation, this deviation being the result of the angular motion of the mirror during the time occupied by the light in passing twice over the space which separated it from the fixed mirror.

A second similar fixed mirror was placed beside the former: it permitted us to make the experiment with air and water simultaneously.

If the lengths traversed had been equal for both media, the times occupied in passing them would be in the ratio of 4 : 3 or of 3 : 4, according to the one or the other theory, and the deviations produced by the rotation of the mirror would have been in the same ratio.

Instead of equal lengths, we have adopted equivalent lengths; that is to say, lengths traversed by the light in equal times. These lengths are very different, according as they are calculated from the one or the other theory. The length for water being 1, the equivalent length for air would be $\frac{3}{4}$ by the theory of emission, and $\frac{4}{3}$ by the theory of undulation.

If the experiment be made by adopting the length $\frac{3}{4}$ for air, that of water being 1, according to the theory of emission, the times occupied by the two bundles of light in passing over these spaces will be equal, and consequently the deviations will be equal. By the other theory, on the contrary, the times occupied by the light in passing through both media, will be very different; these times will be for water and for air in the ratio of 16 to 9, and the deviations will be in the same ratio.

To coincide with the one or the other theory, it will therefore be sufficient to prove, either that the deviations are equal, or that one is nearly double the other.

If the equivalent lengths calculated from the theory of undulation be taken, the results will be similar, but inverse.

According to the theory of emission, the deviations will be in the ratio of 16 : 9; according to the other theory, they will be equal.

We have made these two experiments, and the results obtained are very exact. The phenomena observed are altogether in accordance with the theory of undulation, and in manifest opposition to the theory of emission.

In the first arrangement the deviation is greater for water than for air; it is nearly double. The difference is sensible with a velocity of 400 or 500 revolutions per second, with a velocity of 1500 revolutions it becomes quite evident.

In the second arrangement the deviation is the same for air and water; and whatever be the velocity of the mirror, there is no sensible difference between the two deviations.

These experiments have been made in the meridian room of the observatory; the column of water was 2 metres long, and was contained in a crystal tube closed at the ends with glass. This length is more convenient than that which we at first employed, namely, 3 metres. The light is less weakened, and, after its double passage, retains an intensity which may be estimated at double of that which was obtained with the tube of three metres.

The deviations were observed at a distance of 1·50 millim. from the rotating mirror.

On the Law of the Compressibility of Water at different Temperatures.

By W. J. MACQUORN RANKINE, *F. R. S. E. &c.*[*]

Having lately had occasion, in the course of some theoretical researches on the velocity of sound in liquids, to endeavor to represent the experiments of M. Grassi on the compressibilities of distilled water at different temperatures (*Comptes Rendus*, XIX.) by an empirical formula, I was much struck on unexpectedly finding that they followed sensibly this law:—

The compressibility of water is inversely proportional to the density multiplied by the temperature, as measured from the absolute zero of a perfect gas-thermometer, viz: a point 274°·6 below the ordinary zero of the Centigrade scale, and 462°·28 below that of Fahrenheit's scale.

[*] From the London, Edinburgh, and Dublin Philosophical Magazine, June, 1851.

Hence the compressibility of water varies according to the same law with that of a gas.

To express the law symbolically, let $\mathfrak{d}$ represent the fraction by which unity of volume of water is compressed by a pressure of one atmosphere, D the density of the water, its maximum density being taken as unity, and τ the temperature measured from the absolute zero; then

$$\mathfrak{d}=\frac{1}{K\tau D}.$$

K is a constant coefficient, the value of which is—

For the Centigrade scale, 72 atmospheres per degree.

For Fahrenheit's scale, 40 atmospheres per degree.

The following table exhibits a comparison between the results of the formula and those of M. Grassi's experiments. It will be observed, that the discrepancies are extremely small, and follow no regular law, being sometimes positive and sometimes negative.

The value of the single constant in the formula K was deduced from the mean of the first and second experimental results. The values of the density D were computed by means of the empirical formula in my paper On the Expansion of Liquids, published in the Edinburgh New Philosophical Journal for October, 1849.

Temperature Centigrade from the ordinary zero.	Compressibility of water per atmosphere of pressure.		Differences.
	Calculated.	Observed.	
0°	0·000050584	0·000050560	—0·000000024
10·8	0·000048679	0·000048705	+0·000000026
13·4	0·000048252	0·000048378	+0·000000126
15 5	0·000047915	0·000047745	—0·000000170
25·9	0·000046353	0·000045843	—0·000000510
34·8	0·000045140	0·000045573	+0·000000433
43·0	0·000044158	0·000044414	+0·000000256
53·3	0·000042931	0·000044336	+0.000001405

As it has not yet been ascertained whether this law is applicable to other liquids and to water at higher temperatures, I refrain for the present from drawing any theoretical conclusions from it.

London, March 1851.

For the Journal of the Franklin Institute.

Notes on the U. S. Tug Steamer "Engineer." *By* B. F. Isherwood, *Chief Engineer U. S. N.*

The "Engineer" is a small tug steamer attached to the Gosport Navy Yard, Va. The following particulars may be of advantage in the way of steam statistics:

Hull.—Length between perpendiculars, 105 feet; beam, 17 feet 2 inches; depth of hold, 6 feet 11 inches; mean draft, 4 feet 6 inches; depth of keel, 6 inches; thickness of bottom plank, 2 inches; of wales, 3 inches; of siding frames, 4 inches at head and 8 inches at heel. Area of immersed amidship section, 61 square feet.

Engine.—One beam engine; diameter of cylinder 25 inches; stroke of piston, 7 feet; space displacement of piston per stroke, 23,863 cubic feet.

Paddle Wheel.—Of the common radial kind; diameter from outside to outside of paddles, 17 feet; length of paddle, 4 feet 3 inches; width of paddle, 1 foot 6 inches; thickness of paddle boards, $1\frac{3}{4}$ inches; number of paddles in each wheel, 14; wooden arms, $6\frac{1}{2}$ inches by 3 inches; immersion of lower edge of paddles, 29 inches; paddle-wheel shaft of cast iron, $6\frac{5}{8}$ inches diameter in main journal; area of one paddle, 6·375 square feet; number of paddles immersed in each wheel, 3.

FIG 1.

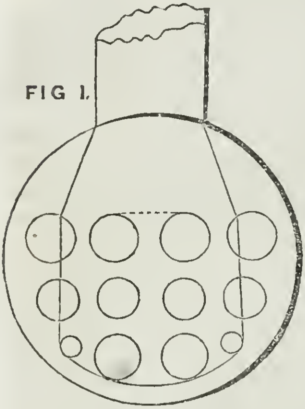


FIG. 2.

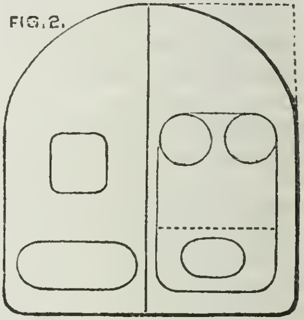


FIG. 3.

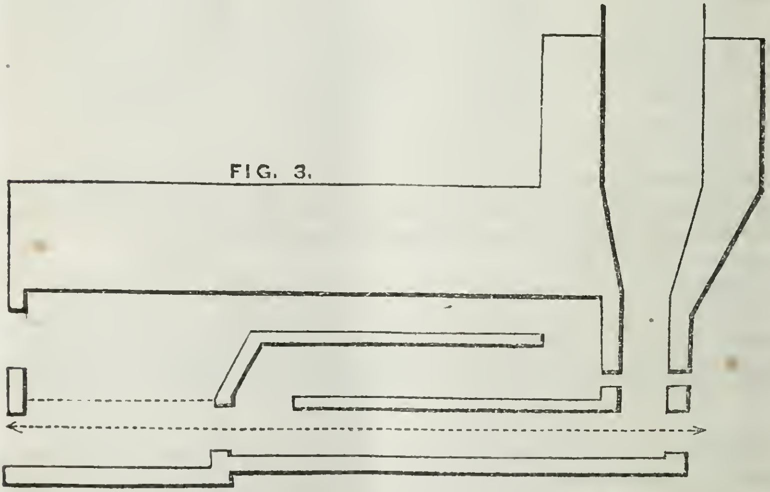


Fig. 1, cross section through flues. The straight lines show the connexion under smoke pipe.

Fig. 2, elevation—section through furnace.

Fig. 3, longitudinal section through flues.

Boiler.—One iron boiler of the "double return drop flue" variety, 17 feet long, $7\frac{1}{4}$ feet diameter, with a steam chimney $5\frac{1}{2}$ feet diameter, by 4 feet high above top of boiler; smoke pipe $2\frac{1}{2}$ feet diameter, and 31 feet high above the top of steam chimney; two furnaces, 3 feet by 5 feet each; total fire grate surface, 30 square feet; heating surface in furnaces, 128 square feet; in flues 326 square feet; in connexions 62 square feet; total heating surface, 564 square feet; proportion of grate to heating surface, 1· to 18·8; proportion of grate surface to space displacement of piston, 1·257 square feet per cubic foot; proportion of heating surface to space displacement of piston, 23·631 square feet per cubic foot; capacity of steam room, 212 cubic feet, or 8·884 cubic feet per cubic foot of piston displacement.

Calorimeter, or cross areas of	flues at bridge	5·936	square feet,	or 1· to	5·056	of grate.
" " "	middle flues,	4·746	"	"	6·321	"
" " "	back connexions	3·523	"	"	8·501	"
Area of smoke pipe,	- -	4·908	"	"	6·113	"

With these proportions, the boiler furnishes steam for 20·9 double strokes of piston per minute of 21·8 pounds boiler pressure above the atmosphere, with wide throttle, burning 724 pounds of Virginia bituminous coal per hour with natural draught, cutting off at half stroke. Using dry Virginia pine wood, the boiler furnishes steam for 25 double strokes of piston per minute; of 30 pounds boiler pressure above the atmosphere, with wide throttle, burning half a cord per hour, cutting off at half stroke.

The cutting off was effected by an ordinary throttle valve placed in the steam pipe, and worked by a cam-board, operated by a cam on the main shaft. The cubic contents between the cut off valve and the commencement of the stroke of the piston, including clearance, was 2·02 cubic feet. Cutting off at half stroke, there was consequently used at each stroke of piston 13·95 cubic feet of steam. Taking the case in which coal was burned, when 724 pounds of coal per hour gave 20·9 double strokes of piston per minute of steam of 21·8 pounds boiler pressure above atmosphere, and supposing the initial pressure of steam in the cylinder to be two pounds less than in the boiler, or at a total pressure in the cylinder of 34·5 pounds, there would be evaporated per hour 13·95 cubic feet steam × 41·8 strokes of piston × 60 minutes, = 34986·6 cubic feet of steam. The relative volumes of steam and water at a steam pressure of $34\frac{1}{2}$ pounds is $777\frac{1}{2}$ to 1·, and $\frac{34986{\cdot}6}{777{\cdot}5} = 44{\cdot}999$ cubic feet of water. Taking the cubic foot of sea water at 64·3 pounds, 44·999 × 64·3 = 2893·434 pounds of sea water evaporated per hour by 724 pounds of coal, or 3·996 pounds of sea water per hour per pound of coal; to this must be added the loss by "blowing off" at a saturation of $\frac{2}{32}$, which is $11\frac{8}{10}$ per cent. of the total caloric, or 13·38 per cent. of the caloric utilized, and 3·996 × 0·1338 = 0·535 and 3·996 + 0·535 = 4·531 pounds; a very low result, marking a badly proportioned boiler.

In the engine's log from which the above facts are obtained, there is recorded, "the smoke is very black, and fell to the surface of the sea at 16 or 18 yards from the smoke pipe," evidencing a very imperfect combustion; and in a letter from the engineer of the vessel, he remarks, "the draft is remarkably strong," a fact which might have been inferred from the low proportion of heating to grate surface, viz: 18·8 to 1·, which being insufficient for the proper absorption of the caloric from the heated gases, they were delivered into the chimney at a very high temperature; and also from the large consumption of coal per square foot of grate surface, viz: 24·13 pounds. The quantity of clinker formed per hour, was 93 pounds, or 12·43 per cent., an excessive quantity, caused by the high temperature of the furnace resulting from the combustion of so large an amount of coal per square foot. The amount of ashes per hour, was 67·7 pounds, or 9·35 per cent. of the fuel. The amount of sea water evaporated per hour, per pound of coal per square foot of heating surface, was 6·864 pounds, inclusive of the loss by "blowing off," which is altogether too much for the economical use of fuel. In another part of the letter above referred to, from the engineer of the vessel, he says in reply to the question: Does the boiler foam? "Never under ordinary circumstances," which might have been deduced from the consideration that the steam room of the boiler contained 17·768 charges of steam for the cylinder, cutting off at half stroke. The data used in these notes are the mean of 40 hours continuous steaming in Chesapeake Bay, in July, 1849.

The quantity of atmospheric air chemically required for the complete combustion of one pound of bituminous coal, is 150·35 cubic feet. Of this amount, 44·64 cubic feet combines with the gases evolved by the heat from the coal, and the remaining 105·71 cubic feet combines with the solid carbon of the coal. Chemical experiment shows that when the gases (principally hydrogen and oxygen) are combined, the resulting mass is to the mass of atmospheric air required to furnish the oxygen as 10 to 11. The 44·64 cubic feet must therefore be increased in this proportion, and will become 49·104. The gases resulting from combination of the solid carbon and the oxygen, viz: carbonic acid and nitrogen gases, are of exactly the same bulk as the atmospheric air required to furnish the oxygen, viz: 105·71 cubic feet. The total masses then of atmospheric air and gases, will be 49·104 + 105·71 = 154·814. This, it must be remembered, would be the mass of the products of combustion in a *cool* state, and would be expanded by the heat of the furnace into a greater mass. The ordinary heat of a furnace has never been accurately ascertained, but is commonly estimated at about 1000° F., and as the permanently elastic gases follow the law of Mariotte, and expand about $\frac{1}{480}$th for each increment of one degree F., of temperature, it follows that the 154·814 cubic feet could be about trebled, or become 464·442 cubic feet. Taking the velocity of draft from Ure's experiments, at 36 feet per second, or 129600 feet per hour, (a high velocity,) there would be required to pass off 464·442 cubic feet, $\frac{464 \cdot 442}{129 \cdot 600} = 0 \cdot 00358$ square feet per pound of coal, and for 724 pounds, 2·592 square feet. This calorimeter or area of flue would therefore be required, provided a complete combination of the components of the coal and the oxygen of the atmosphere were obtained. Nothing like a complete combination, however, is obtained in practice; but from the experiments of Walter R. Johnson, De la Beche, and others, it appears that about 50 per cent. of the oxygen admitted into the furnaces of steam boilers, passes off uncombined, The above obtained calorimeter should therefore be increased in the proportion of 150 35 to 309·628, or become 5·337; but it was actually at its minimum only 3·529 square feet, or *one-third less than it should have been.* The consequence was, as might have been predicted, a very imperfect combustion, and a shower of uncombined carbon falling at a few rods from the smoke pipe.

The inferior result obtained from this boiler, may be evidenced by the result obtained by Walter R. Johnson, from Virginia bituminous coal used in an experimental boiler. He obtained a mean evaporation of 7·27 pounds of fresh water per pound of coal.

We will now ascertain the result obtained in the boiler of the "Engineer," from the use of dry Virginia yellow pine wood. In the previous notes, it is stated that half a cord of this wood would maintain a steam boiler pressure of 30 pounds above atmosphere, giving 25 double strokes of piston per minute, cutting off at one half. As there would be 13·95 cubic feet of steam used per stroke, there would be used per hour $13\cdot95 \times 50 \times 60 = 41850$ cubic feet; taking the initial pressure of the steam in the cylinder at two pounds less than in the boiler, we have a total steam pressure of $28 + 14\cdot7 = 42\cdot4$ pounds. The relative volumes of steam and water at this pressure are 643·4 to 1·, and $\frac{41850\cdot}{643\cdot4}$ $= 65.045$ cubic feet of water. Taking the cubic foot of sea water at 64·3 pounds, $65\cdot045 \times 64\cdot3 = 4182.393$ pounds of sea water evaporated by half a cord of wood. The mean weight of dry yellow pine wood per cord as piled, is about 2600 pounds, and $\frac{4182\cdot393}{1300} = 3\cdot217$. Adding to this the same per centage as before, for loss by "blowing off," viz: 13·38 per cent. of the caloric utilized, we have $3\cdot217 \times 0\cdot1338 = 0\cdot430$; and $3\cdot217 \times 0\cdot430 = 3\cdot647$ pounds of sea water evaporated per pound of wood. The evaporation per pound of coal being 4·531 pounds it follows that for equal weights, the coal is more efficient in the proportion of 1·242 to 1·000. From these figures, it also appears that the efficiency of one ton of Virginia bituminous coal of 2240 pounds, compared to that of one cord of Virginia dry yellow pine wood of 2600 pounds, is as 2782·08 to 2600·00, or as 1·07 to 1·00.

Performance.—The "Engineer" ran in Chesapeake Bay 360 miles in 39½ hours, or at the rate of 9·057 miles per hour. Double strokes of engine per minute, 20·9. Steam pressure in boiler above atmosphere, 21·8 pounds. Back pressure in condenser, 2·2 pounds; cut off at half stroke of piston. Supposing (which will be very near the truth as found in practice), that the initial steam pressure in the cylinder is two pounds less than in the boiler, we shall have a total initial steam pressure in cylinder of $(21\cdot8 - 2 + 14\cdot7 =)$ 34·5 pounds. Half the piston space displacement per stroke is 11·93 cubic feet, and the space comprised between the cut off in the steam pipe, and the piston at the commencement of the stroke, including clearance, is 2·02 cubic feet, making a total of 13.95 cubic feet of steam to be expanded into $(13\cdot95 + 11\cdot93)$ 25·88 cubic feet: $\frac{25\cdot88}{13\cdot95} = 1\cdot855$, the hyper. log. of which is 0·6179, and $0·6179 \times 11·93 = 7·3715$, and $1· \times 13·95 = 13·95$, and $\frac{7·3715 \times 13·95}{23·863} = 0·894$ = average effect of steam throughout stroke of piston, and $34·5 \times 0·894 = 30·84$. Allowing the back pressure in the cylinder to exceed that in the condenser by 2 pounds, as found in practice, there would be a back pressure on the piston of 4·2 pounds to be deducted, leaving (30·84 — 4·20) 26·64 pounds as the mean effective pressure per square inch on the piston throughout the stroke.

The area of the piston being 490·875 square inches, and its stroke 7 feet, the horses power developed by the engine will be as follows:

$$\frac{490·875 \times 26·64 \times 41·8 \times 7}{33000} = 115·95 \text{ horses power.}$$

The circumference of the circle of the centre of resistance of the paddles is 50·391 feet, and

$50·391 \times 20·9 \times 60 = 63190·31$ feet = speed of centre of reaction of paddles per hour.
$9·057 \times 5280 = 47820·96$ " = " " vessel per hour.

15369·35 " = slip of centre of reaction of paddles per hour.

Or at 24.32 per cent.

The loss of labor from the oblique action of the paddles on the water, calculated as the squares of the sines of the angles of incidence, is 13·07 per cent.

Estimating the power required to work the engine at 2 pounds per square inch of piston, for an engine of this small size and great steam pressure, we have 7·51 per cent. of the total power thus consumed.

Taking from the experiments of Morin on friction 0·075 for the coefficient of friction for the load, and deducting first from the total mean effective pressure on the piston per square inch, viz: 26·64 pounds, the 2 pounds for working the engine, there remains 24·64 pounds, 0·075 of which is 1·848, and 1·848 is 6·94 per cent. of 26·64; 6·94 is therefore the per cent. of the total power developed by the engine, consumed in the friction of the load.

Collecting the above, we have the following:

Disposition of the power.

Slip of the centre of reaction of the paddles,	21·32	per cent., or	28·20	horses' power.
Oblique action of the paddles, - -	13·07	" " "	15·15	" "
To work the engine, - - - -	7·51	" " "	8·71	" "
Friction of the load, - - - -	6·94	" " "	8·05	" "
Leaving to be utilized in the propulsion of the vessel, - - - - -	48·16	" " "	55·84	" "
Totals,	100·00		115·95	

The "Engineer" can tow a frigate at the rate of 2½ miles per hour. She is badly proportioned for a Tug, her wheels having too great a diameter for the power, consequently opposing too great a leverage for the engine to at all develope the power of the boiler, while at the same time, the paddles have altogether too little immersed surface to obtain the necessary resistance in towing; a great waste of effect in slip, is the inevitable result.

On Atmospheric Magnetism. *By* PROFESSOR FARADAY.

From the Proceedings of the Royal Institute of Great Britain, April 11, 1851.

On a former evening (January 24), it was shown that oxygen gas was magnetic, being attracted towards the poles of a magnet; and that like other magnetic bodies, it lost and gained in power as its temperature was raised and lowered, and that the change occurred within the range of natural temperatures. These properties it carries into the atmosphere; and the object, this evening. was to show how far they might be applied to explain certain of the observed variations of the terrestrial magnetic force.

If a source of magnetic power be considered (as a magnet) it presents us with a system having polarity; and if the parts which are called the poles be taken as representing the most concentrated condition of the polarity, then the contrary polarities, manifest externally in relation to the magnet, are perfectly definite, being exactly equal to each other. If the magnet be irregular in the disposition of its force, still the same definite character of the sum of the contrary polarities holds good.

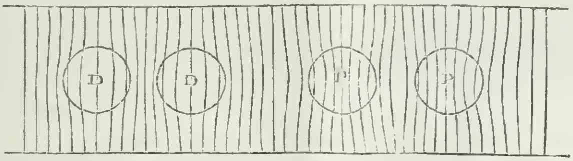
External to the magnet those concentrations which are named poles may be considered as connected by what are called magnetic curves, or lines of magnetic force, existing in the space around. These phrases have a high meaning, and represent the ideality of magnetism. They imply not merely the directions of force, which are made manifest when a little magnet, or a crystal, or other subject of magnetic action, is placed amongst them, but those lines of power which connect and sustain the polarities, and exist as much when there is no magnetic needle or crystal there as when there is; having an independent existence analogous to (though very different in nature from) a ray of light or heat, which, though it be present in a given space, and even occupies time in its transmission, is absolutely insensible to us by any means whilst it remains a ray, and is only made known through its effects when it ceases to exist. The form of a line of magnetic force may vary exceedingly from a straight line to every degree of curvature, and may even have double and complicated curvatures impressed upon it. Its direction is determined by its polarity, the two changing together. Its powers are such, that a magnetic needle placed in it finds its place of rest parallel to it; a crystal of calcareous spar turns until its optic axis is transverse to it; and a wire which is unaffected when moved in or along it, has an electric current evolved the instant that it passes across it: by these and by other means the presence of the magnetic line of force and its direction are rendered manifest.

The earth is a great magnet: its power, according to Gauss, being equal to that which would be conferred if every cubic yard of it contained six one-pound magnets; the sum of the force therefore is equal to 8,464,000,000,000,000,000,000 such magnets. The disposition of this magnetic force is not regular, nor are there any points on the surface which can be properly called poles: still the regions of polarity are in high north and south latitudes; and these are connected by lines of magnetic force (being the lines of direction) which, generally speaking, rise out of the earth in one (magnetic) hemisphere, and passing in varied directions over the equatorial regions into the other hemisphere, there enter into the earth to complete the known circuit of power. A free needle shows the presence and direction of these lines. In London they issue from the earth at an angle of about 69° with the horizon (being the dip or inclination); and the plane in which they rise forms an angle of 23° W. nearly with true north, giving what is called west declination. Where the dip is small, as at the magnetic equator, these lines scarcely rise out of the earth, and pass but a little way above the surface; but where it is large, as in northern or southern latitudes, they rise up at a greater angle, and pass into the distant realms of space, from whence they return again to the earth in the opposite magnetic hemisphere; thus investing the globe with a system of forces like that about an ordinary magnet, which wherever it passes through the atmosphere, is subject to the changing action of its magnetic oxygen. There is every reason to believe that these lines are *held* in the earth, out of which they arise and by which they are produced, just as the lines which originate in a magnet are held by it, though not in the same degree; and that any disturbance from above affecting them, will cause a greater change in their place and direction, in the atmosphere and space above, than in the earth beneath.

The system of lines of magnetic force around a magnet or the earth is related by a lateral tension of the whole, analogous in some degree to the lateral tension of lines of static electrical force; both the one and the other being easily made manifest by experiment. The disturbance of the tension in one part is accompanied instantly by a disturbance of the tension in every other part; for as the sum of the external powers of a system, unaltered at its origin, is definite and cannot be changed; so any alteration, either of intensity or direction amongst the lines of force at one place, must be accompanied by a corresponding change at every other. So if a mass of soft iron on the east side of a magnet causes a concentration of the lines of force from the magnet on that side, a corresponding expansion or opening out of the lines on the west side must be, and is at the same time produced; or if the sun, on rising in the east, renders all the oxygen of the air on that side of the globe less magnetic, and less able therefore to favor the transition of the lines of terrestrial force there, a greater number of them will be determined through the western region; and even though the lines of force may be doubted by some as having a separate existence, such as that above assumed, still no error as to the effects on magnetic needles would in that case be introduced, for they by experiment would be and are the same.

The power of a magnetic body as iron or oxygen to favor the transmission of lines of force through it more than other bodies not magnetic, may be expressed by the term conduction. Different bodies, as iron, nickel, oxygen, conduct in various degrees, and not only that, but the same body as iron or oxygen conducts in different degrees at different temperatures. When space traversed by uniform lines of magnetic force is occupied by a uniform body as air, the disposition of the lines is not altered; but if a better conducting substance than the air is introduced, so as to occupy part of the space, the lines are concentrated in it, and drawn from other parts as shown by P P in the figure, or if a worse conducting substance is introduced, the lines are opened out as at D D.

In both cases the lines of force are inflected, and a small magnetic needle standing in them at the inflected part, would have its direction changed accordingly. Experimental illustrations of these changes in direction are given in Mr. Faraday's paper in the Philosophical Transactions for 1851, Part I. Par. 2843, &c.



Now this by the hypothesis is assumed to take place in the atmosphere. Supposing it all at mean temperature, the lines of force would have the direction determined by the arrangement of the power within the earth. Then the sun's presence in the east would make all the atmosphere in that region a worse conductor, and cause it to assume the character of D; and as the sun came up to and passed over the meridian and away to the west, the atmosphere under his influence would bring up changes in direction like those shown in either D or D; it would therefore manifestly set a needle in a given latitude in opposite directions as it passed by; and as evidently set two needles in north and south latitudes in opposite directions at the same moment of time. As the night came on, and a temperature lower than the mean came up from the east and passed over, the lines of force would be inflected as in P or P , and a reverse variation of the needle to that which occurred before, would now take place.

That natural effects of variation must be produced consequent upon the magnetic nature of oxygen and its daily variations of temperature, is manifest; but whether they cause the observed variations, or are competent to do so, is a question that can only be decided after very careful inquiry. Observations are now made on the surface of the earth with extreme care in many places, and these are collated, and the average or mean result, as to direction and intensity of the earth's force, ascertained for every hour and season; and also many remarkable, anomalous, and extra results evolved. A theory of the causes of any or all of these variations may be examined first by the *direction* which the varying needle does or ought to assume, and then by the *amount* of the variation. The hypothesis now brought forward has been compared with the mean daily variation for all the months in the year at north and south stations, as Toronto and Hobarton, and at many others near to and far from the equator, and agrees in direction with the results observed far beyond what the author anticipated. Thus the paths described by the upper ends of free needles in the north and south hemispheres should be closed curves, with the motion in opposite and certain directions, and so they are:—the curves described by needles in north or south latitudes should be larger in summer and smaller in winter, and so they are:—a night or cold action should grow up in the winter months, and such is the case:—the northern hemisphere ought to have a certain predominance over the southern, because of its superior temperature, and that is so:—the disposition of land and water ought to have an influence, and there is one in the right direction:—so that in the first statement and examination of the hypothesis, it appears to be remarkably supported by the facts. All these coincidences are particularly examined into and stated in the Philosophical Transactions already referred to. The next step will be to ascertain what is the amount of change in the conducting power of the air for given changes of temperature, and then to apply that in the endeavor to ascertain whether the amount of change to be expected is (as well as the direction) accordant with that which really occurs.

For the Journal of the Franklin Institute.

A Series of Lectures on the Telegraph, delivered before the Franklin Institute.

Session, 1850–51. *By* Dr. L. Turnbull.

Continued from page 61.

Gauss and Weber Electro-Magnetic Needle Telegraph.

Counsellor Gauss and Professor Weber, two of the most illustrious philosophers of Germany, to whom the science of magnetism is deeply indebted, entered nobly into the list in establishing, by means of electricity, telegraphic communication between the Astronomical Observatory, Physical Cabinet, and Magnetic Observatory, at Gottingen, the first notice of which is found in Göt. Gel. Anz., 1834, 1273, and in 1836, Schumacher Jahrback, p. 38–39. It consisted of a double line of wire carried over the houses and steeples at Gottingen. It was constructed chiefly for the purpose of being able to make investigations respecting the laws of the force of galvanic currents on a large scale, under different circumstances. The circuit employed in 1833 was about nine thousand feet; and in 1834 or 1835, at least fifteen thousand, but part of this wire was reeled. The form of wire employed was mostly copper, of the size known in commerce as No. 3, of which a length of one metre weighs eight grammes; the wire of the multiplier in the Magnetic Observatory was of silvered copper, No. 14, of 2·6 metres to the gramme. They first employed galvanic electricity by employing small sized plates, and found that the action was much increased by adding to their number. They repeated and perfected their first form of telegraph, by applying the phenomenon of magnetic induction, discovered by Prof. Faraday. The divers movements or the slow oscillations of magnetic bars, caused by the passage of the currents, and observed by the aid of a glass, furnished to Gauss and Weber all the signals which they wished in corresponding, but the number of signals which could be transmitted was few, and the time occupied by each considerable.

The main apparatus was a magneto-electric machine, and to this, Counsellor Gauss adapted a peculiar arrangement, by which the direction of the current can be reversed by a single pressure of the finger.

Professor Weber had a delicate apparatus for setting off an alarm of a clock, placed at the side of the magnet in the physical cabinet, by means of the current conducted from the observatory.

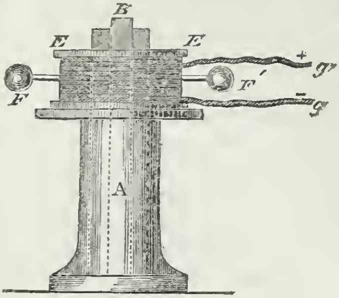
The telegraphing apparatus consisted of the following parts:

1. The apparatus for generating the galvanic current.
2. The apparatus for observing the given signal.

3. The apparatus for the sudden reversing of the current, or the commutator (*pole changer*).

In the column A, fig. 20, are two or three strong magnet bars (each of 25 pounds) united in one strong magnet—their poles of the *same name* (like poles) are visible at B. Over these bars the reel E is placed (of course having a hole for the bars to pass through), and around its external surface a copper wire (insulated by silk winding) is wound.

Fig. 20.

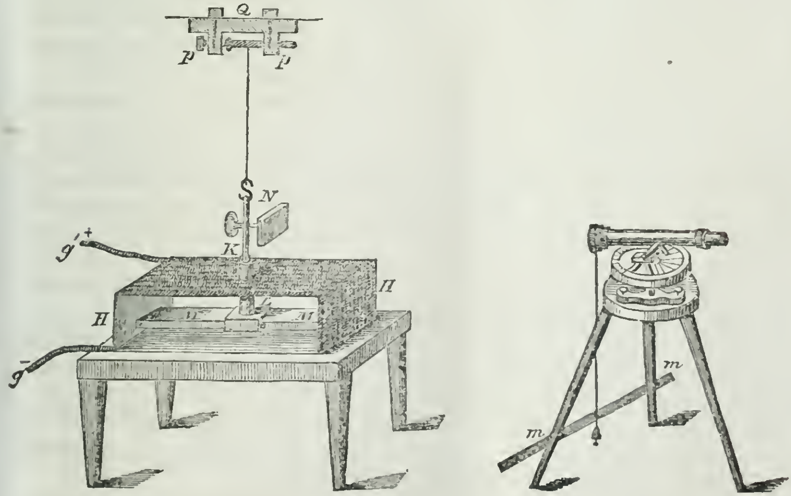


At the first arrangement, Gauss gave the reel 1050 coils; by a late arrangement, he increases the number of coils to 3537, with a length of wire of about 3600 feet; and still later, he used a reel with 7000 coils with a length of wire of more than 7000 feet.

The two ends, *g g'*, of this reel, E, (which on account of their inductive action are called *inductors*) are in connexion with a commutator (pole changer), and through that with the two principal conducting wires of the telegraph. If the inductor is taken by the two handles F F', and suddenly drawn off the magnet bars on which it rests, and immediately, without turning it round, replaced in its former resting place, there results two induction currents, one immediately after the other, in opposite directions, passing through the conducting wire; the duration of these currents is very short. Their intensity depends upon the strength of the united magnets in A, upon the number of coils in the inductor E, and upon the distance these coils are from the magnets.

Fig. 21 represents the *observing apparatus*.

Fig. 21.



Whilst the inductor is set up at the station whence the signal is to be telegraphed, the observing apparatus is placed at the station where the communication is to be received.

It consists of a strong *multiplicator*, H H, that is to say, of a copper frame, around which an insulated wire is coiled. The two ends of the wire *g g* are connected with the two chief conducting wires coming from the other station, so that the multiplicator wire forms with the wire coiled on the inductor E, fig. 20, a single closed wire circuit.

At first, the multiplicator had 270 coils of wire, 2700 feet long; in later trials, it had 610 coils of wire, more than 6000 feet long.

In the coils of this multiplicator, there hangs for a magnetic needle a magnetic bar, M M, of at most 4 pounds in weight (later, 25 lb. magnetic bars were used), which is suspended by a thread easily movable in the *little ship* L. This thread consists of 200 parallel cocoon threads, and is fastened to a wooden screw, P Q P, at the ceiling of the room, by which it can be raised or lowered.

On the brass rod K, which passes through the copper frame H H, there is a vertical mirror, N, which turns with the magnet, and is directed in such a manner towards the *cypher scale*, *m m*, fastened at the foot of the stand of the spy-glass, R, that the image of the parts of the scale can be seen in the mirror through the spy-glass.

3. The apparatus contrived by Gauss for the rapid change of the direction of the current was somewhat complicated—but any other simple *commutator* can be used for the same purpose.

The following is the mode of using this telegraph: At the station from which a communication is to be sent, the inductor E, fig. 20, is suddenly drawn off, and again, without turning it round, thrust down upon the magnet pole B, by which means two induction currents of opposite directions are passed through the conducting wire.

By means of the first current, the magnet in the observing apparatus, fig. 21, at the other station, through the action of the multiplicator's coils, is made to diverge in a determined direction, for example, to the right. By means of the second current in the opposite direction, it is immediately stopped, so that the magnet can make no further *excursions*, but only, in consequence of the two opposite currents, makes a little lively vibration to one side, and then immediately remains quite still.

These small motions of the magnet are observed through the spy-glass R, fig. 21, in the mirror N.

In a state of rest, the image of the null point of the scale, *m m*, is visible through the spy-glass; by the motion of the magnet, the mirror is also moved, and reflects to the spy-glass another part of the scale. In this manner, the smallest motion of the magnet is perceptible by the spy-glass.

Accordingly as the commutator (which is directly attached to the inductor) is fixed, the *first* induction current passes in one or the opposite direction through the conducting wire—and therefore, by a sudden drawing off and thrusting down of the reel E, fig. 21, a magnetic vibration to the right or left at the other station can be produced at pleasure.

By an ingenious combination of several magnetic motions, to form a signal, Gauss and Weber were able to make all requisite signs (letters and cyphers) with these two *motions* (*first blows*).

The following are the alphabetical signs, as arranged:—

r = a
l = e
r r = i
r l = o
l r = u
l l = b
r r r = c k
r r l = d
r l r = f v
l r r = g
l l l = h
l l r = l
l r l = m
r l l = n
r r r r = p
r r r l = r
r r l r = s
r l r r = t
l r r r = w
r r l l = z
r l r l = 0
r l l r = 1
l r r l = 2
l r l r = 3
l l r r = 4
l l l r = 5
l l r l = 6
l r l l = 7
r l l l = 8
l l l l = 9

The variations of the magnetic needle signify a letter; *l* denotes a variation to the left, and *r* to the right, and by the combined deflexion of the needle, words and sentences may be transmitted.

Experiments of Messrs. Taquin and Ettieyhausen.

Messrs. Taquin and Ettieyhausen made experiments with a telegraphic line over two streets in Vienna, 1836. The wires passed through the air and under the ground of the Botanic Garden.—*Polytechnic Central Journal*, 1830, *Vail Electro-Magnetic Telegraph*, *p.* 189.

MORSE'S ELECTRO-MAGNETIC TELEGRAPH.

In the latter part of the year 1832, Samuel F. B. Morse, an ingenious American artist, while on a voyage homeward from Europe, conceived the idea of an electric or electro-chemical telegraph, and devised a system of signs for letters, to be marked by the breaking and closing of the electric or galvanic current.

Dr. C. T. Jackson, of Boston, a fellow passenger, well versed in the science of chemistry and electricity, and having witnessed numerous experiments during a recent visit to Paris, afforded him considerable assistance.

The following is a brief account of the methods proposed:—

1st. That electricity might be made visible in any part of the circuit, by dividing the wire, when a spark would be seen at the intersection.

2d. That it could be made to perforate paper if interposed between the disconnected wires.

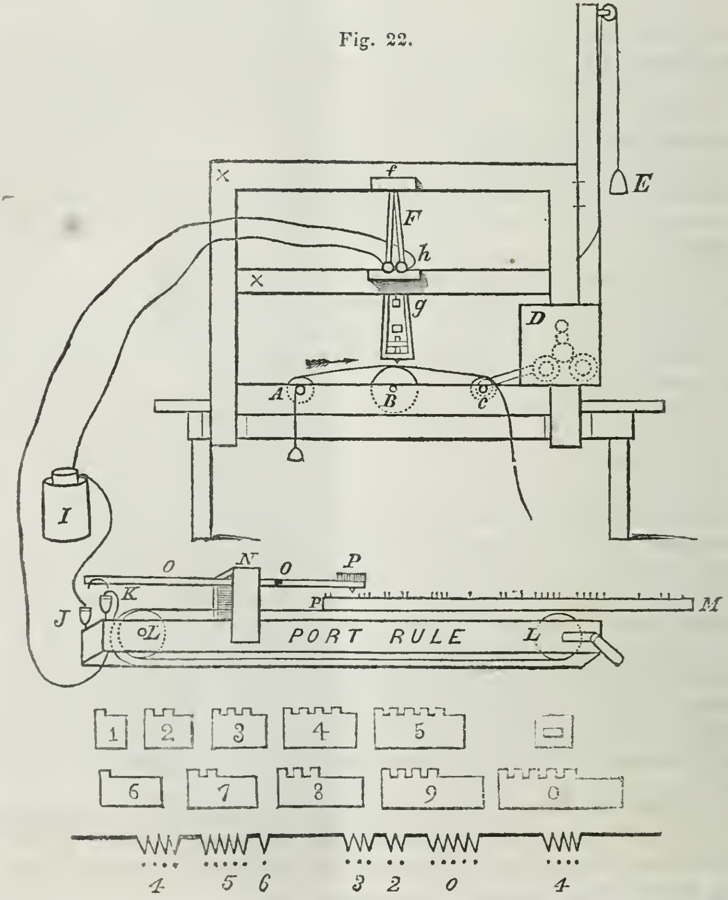
3d. Saline compounds might be decomposed, so as to produce colors on paper.

The 2d and 3d projects were adopted for future trial, since they would furnish permanent records; the saline substances mentioned, were the acetate and carbonate of lead, which when decomposed by the galvanic current, left black marks on the prepared paper; again, tumeric paper, moistened in a solution of sulphate of soda, left brown marks on the passage of the current, produced by the disengaged alkalie. Platina points were also proposed to effect the changes in color.

Mr. Morse experimented for some time after arriving in New York, independent, however, of Dr. Jackson. While on board the Sully, Dr. Jackson doubtless materially aided Mr. Morse in his conception of the electric telegraph, though they do not appear to have had any subsequent connexion, nor was the instrument they devised brought into practical use.

From a careful examination of all the evidence given by the passengers on board of the packet ship Sully, the telegraph devised by Morse and Jackson was not an electro-magnetic telegraph, but an electric or electro-chemical telegraph (see letters of Dr. Jackson to Mr. Morse, and Morse's pamphlet, and letters of J. Francis Fisher, Esq., of Philadelphia). Mr. Morse cast some type in 1833, but from limited circumstances, was compelled to desist from farther experiment, until his appointment to a professorship in the University of New York, in 1835, when he formed the annexed mechanical arrangement, which is interesting from the fact, that it is the basis on which a long series of improvements have been made to bring the instrument to its present unique construction. He exhibited it in January, 1846, to Mr. L. D. Gale, a colleague professor in the University, of high scientific attainment, who afterwards joined Mr. Morse in his enterprise, and made some useful suggestions for its improvement. But becoming satisfied that the electromagnetic power was more available for telegraphic purposes, as exemplified by the experiments of Prof. Henry and his own trials, he directed his attention to that agent. Mr. Gale gives the following description of the instrument, in his evidence in the case of F. O. J. Smith *versus* Hugh Downing:—

Fig. 22.



"A train of clock wheels were used to move a strip of paper, one half an inch in breadth. A, B, and C, are cylinders; the paper is unrolled from passing over the cylinder B to C, where it is connected to the clock work D, moved by the weight E. F is a wooden triangular shaped pendulum, suspended from the pivot *f*, over the centre of the cylinder B; its vibrations were across the paper, or at right angles to the motion of the latter. Through two cross-pieces in its lower part was fixed a pencil case, containing a pencil moving readily up and down, but kept in contact with the paper by a light weight, *g*.

An electro-magnet was fixed on the shelf *h*, which projected from the frame *XX*; this magnet attracted an armature affixed to the pendulum. One of the conductors of the magnet helix, passed to the single plate galvanic battery I, while the other joined the cup of mercury at the port rule K. The other pole of the battery was connected by a wire to the other cup of mercury J. The lower table represents a port rule; it consists of a rude frame containing two cylinders L L, two inches in diameter and two inches long, one turned by a crank, and that turning the other by a band one and half inch in width.

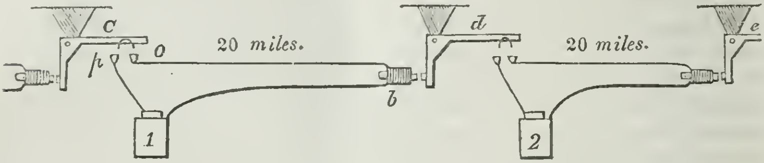
M, is a rule or composing stick, made of two small thin rules, two feet long, placed side by side, separated sufficiently far to form a trough for the type; the tops or cogs of the latter, are seen rising above the top of the rule M. A lever O O, is suspended from the united top of two standards that rise from the sides of the long frame of the post rule, on one end of which is a fork of copper wires that plunges when the lever is depressed into the two mercury cups K and J. A weight is attached to the other extremity to keep it down, and beneath this is a tooth, similar to the keys of a hand organ. There were eleven types one-eighth of an inch thick, having from one to five projections called cogs, save one that was used for a space. The first five numbers consisted from one to five cogs respectively, followed by a space, while the second five were the same, only having a long space double that of the first.

If, as an example, it was desired to send the number 456, the types 4, 5 and 6, with a space to separate them from the successive ones, were set up in the port rule M, which was placed on the bands of the port rule and sent forward by turning the crank; the cogs of the type operating the lever O O, broke and closed the circuit at the battery I; this being done, the magnet *h*, attracted the pendulum F, and moved the pencil *g*, about one-fourth of an inch; the pencil being in contact with the paper while it was moving, a continuous straight line was marked on it if the pendulum was stationary either at one or the other limit of its motion; but when attracted by the magnetic force, it marked a V shaped point as seen in the drawing; the points were marked on the moving paper as there shown by the successive breakings and closings of the circuits through the cogs of the type; the extremities of the V shaped marks were recognised for the figures by their number."

A dictionary was prepared, in which words were arranged in a manner that the numbers would represent them.

Mr. Morse found himself unable to make use of his instrument for great distances, from the resistance to, and dissipation of, the electrical current along the conductors. To overcome the difficulty, he adopted in the spring of 1837, a receiving magnet and a relay or repeating circuit. We do not know by whom this was suggested, but its principle is based on the discoveries made by Prof. Henry, relative to the intensity magnet. Prof. Gale, Dr. Fisher, and Mr. Chilton, had referred Prof. M. to these investigations of Prof. Henry. Prof. Wheatstone, of London, exhibited to Profs. Henry, of Washington, and Bache, of the U. S. Coast Survey, in February, 1837, a repeating circuit which was closed by the deflexion of a galvanometer needle.

Fig. 23.



The one used by Mr. Morse is represented in the accompanying diagram. By means of the receiving magnet, the current of one battery was used to set off that of a second, the second a third, and so on, the last circuit being as strong as the first. 1 is a battery at one terminus of one line of conductors representing twenty miles in length; from one pole of which the conductor proceeds to the helix of an electro-magnet at the other terminus, (the helix forming part of the conductor;) from thence it returns to the battery and terminating in a mercury cup O. From the contiguous mercury cup, *p*, a wire proceeds to the other pole of the battery.

When the fork of the lever O, unites the two cups of mercury, the circuit is complete, and the magnet *f* is charged, and attracts the armature of the lever *d*, which connects the circuit of the battery 2 in the same manner, which again in turn operates the lever *e*, twenty miles further, and so on.

Publicity was given to it through the columns of the New York Observer, on the 15th of April, 1837, in consequence of an announcement that Messrs Gour and Servell had produced an instrument of miraculous capacity, to transmit information, which was, however, only an example of the visual telegraph; it was likewise noticed in the New York Journal of Commerce of April 27, 1837.

In September of the same year, an exhibition of the instrument working through 1700 feet of wire, was given at the New York University, to numerous visiters, among whom were some eminent scientific gentlemen. An account of this was given in the New York Journal of Commerce, of that date.

The ability of the instrument was so skilfully displayed, that Messrs. George and Alfred Vail were induced to "interest themselves in the invention, and furnish Prof. Morse with the means, material, and labor for an experiment on a larger scale;" at this time operations were commenced at the Speedwell Iron Works, near Morristown, New Jersey.

On the 10th of March, 1837, the Hon. Levi Woodbury, then Secretary of the Treasury, issued a circular, requesting information in regard to the propriety of establishing a system of Telegraphs for the United States. Prof. Morse sent three replies to this circular, containing an account of his invention, its proposed advantages, and probable expense, with a description of the kind of conductors required; two of these letters dated respectively, September 27th, 1837, and November 28th, 1837, were included in a report of the Secretary to the House of Representatives, on the 6th of December, 1837. In this report, Mr. Woodbury gave a favorable view to the subject of telegraphing.

Some extracts from Prof. Morse's letters, will show how far real progress has exceeded his expectations at that time, and the modifications that have since been made.

September 27th, 1837.—"The principal expense will be the first cost of the wire, or metallic conductors, (consisting of four lengths,) and the securing them against injury. The cost of single copper wire $\frac{1}{16}$ of an inch in diameter, (and it should not be of less dimensions) for 400 miles was recently estimated in Scotland, to be £1000 sterling, including the solderings of the wires together, that is, $6 per mile for one wire."

"Iron tubes enclosing the wires, and filled in with pitch and resin, would probably be the most eligible mode of securing the conductors from injury, while at the same time it would be the most costly." "Iron tubes of $1\frac{1}{2}$ inch diameter, I learn, can be obtained at Baltimore, at 28 cents per foot. The trenching will not be more than three cents for two feet, or about $75 per mile." "If the circuit is laid through the air, the first cost will doubtless be much lessened." "Stout spars of some thirty feet in height, well planted in the ground, and placed about 350 feet apart, would in this case be required, along the tops of which the circuit might be stretched. Fifteen such spars would be wanted to a mile. This mode would be as cheap, probably, as any other, unless the laying of the circuit in the water should be found the most eligible." "I presume that five words can be transmitted in a minute; for, with the imperfect machine I now use, I have recorded at that rate, at the distance of half a mile."

November 28th, 1837.—"We have procured several miles of wire, and I am happy to announce to you that our success has, thus far, been complete. At the distance of five miles, with a common Cruikshank's battery of 87 plates, (4 by $3\frac{1}{2}$ inches each plate,) the marking was as perfect on the register as in the first instance of half a mile. We have recently added *five miles more*, making in all *ten miles*, with the same result, and we have no doubt of its effecting a *similar result* at *any distance*."

The instrument was partially described in Prof. Silliman's Journal of October, 1837, which was afterwards copied in the November number of the Journal of the Franklin Institute of the same year, and the London Mechanics' Magazine of February, 1838.

A model enclosing a circuit of ten miles of insulated wire wound upon two reels, was finished in the latter part of the year 1837, and intended for an exhibition before Congress. This was soon after shown in the Hall of the Franklin Institute of this city, where it was subjected to the inspection of a committee appointed to examine it; its operation was eminently satisfactory to them, and they did it the honor to give the subjoined favorable report:

"The Committee on Science and the Arts constituted by the Franklin Institute of the State of Pennsylvania, for the promotion of the Mechanic

Arts, to whom was referred for an examination, an electro-magnetic telegraph, invented by Prof. F. B. Morse, of the city of New York, report—That this instrument was exhibited to them in the Hall of this Institute, and every opportunity given by Mr. Morse and his associate, Mr. Alfred Vail, to examine it carefully, and to judge of its operation. * * * *

"As exhibited to us, it was very satisfactory. The power given to the magnet at the register, through a length of wire of ten miles, was abundantly sufficient for the movements required to make the signals. The communication of this power was instantaneous. The time required to make the signals was as short at least as that necessary in the ordinary telegraphs. It appears to the committee, therefore, that the possibility of using telegraphs on this plan, in actual practice, is not to be doubted, though difficulties may be anticipated which could not be tested with the trial made with the model.

"One of these relates to the insulation and protection of the wires, which are to pass over many miles of distance, to form the circuits between the stations. Mr. Morse has proposed several plans; the last being to cover the wires with cotton thread, then varnish them thickly with gum elastic, and enclose the whole in leaden tubes. More practical and economical means will probably be devised; but the fact is not to be concealed, that any effectual plan must be very expensive. Doubts have been raised as to the distance to which the current of an ordinary battery can be made efficient; but the committee think no serious difficulty is to be anticipated on this point. * * * *

"An experiment is said to have been made on the Birmingham and Manchester railroad, through a circuit of thirty miles in length.

"It may be proper to state, that the idea of using electro-magnetism for telegraphic purposes has presented itself to several different individuals, and that it may be difficult to settle among them the question of originality.

"The celebrated Gauss has a telegraph of this kind in actual operation, for communicating signals between the University of Gottingen and his magnetic observatory in its vicinity. Mr. Wheatstone, of London, has been for some time also engaged in experiments on an electro-magnetic telegraph. But the plan of Prof. Morse is, so far as the committee are informed, entirely different from those devised by other individuals, all of which act by giving different *directions* to magnetic needles, and would therefore require several circuits of wires between all the stations.

"In conclusion, the committee beg to state their high appreciation of Prof. Morse's telegraph, and the hope that means may be given him to subject it to the test of an actual experiment made between stations at a considerable distance from each other. The advantages which this telegraph would present, if successful, over every kind heretofore used, make it worthy of the patronage of the government. These are, that the stations may be at a distance asunder far exceeding that to which other telegraphs are limited, and that the signals may be given at night, and in rains, snow, and fogs, when other telegraphs fail.

"By order of the Committee.

"William Hamilton, *Actuary.*

"*Philadelphia, February* 8, 1838."

It was subsequently taken to Washington, and kept in successful operation for several months in the room of the House Committee of Commerce, where it was visited by multitudes of people.

The examining committee were propitious to it, and in a warm and ardent report made on the 6th of April, 1838, urgently advised that it should be subjected to an adequate trial.

Prof. Morse sent in a caveat to secure his invention in October, 1837, filed his specifications, and made application for a patent in April, 1838, but withdrew them afterward, that he might be enabled to obtain patents in the European countries. Hon. F. O. J. Smith, a member of Congress, from Maine, was so interested in it, and sure of success, that he left his seat there, and joined Prof. Morse in a trip to Europe, in May, 1838. From the peculiar construction of the English patent laws (which require that the instrument should not have been published), he was unable to obtain a patent there, and though he secured one in France, it afforded him no profit, as his funds were too limited to bring it into operation within two years—the time specified in their patent regulations.

Though he failed at that time to remunerate himself as a monetary speculator, the instrument attracted the attention of scientific men in both countries, who accorded him much merit for the skilfulness of the invention.

It was put in operation at a meeting of the French Academy of Sciences, September 10th, 1838, and a description of it published in their weekly journal, the "Comptes Rendus." On account of the disordered financial condition of the country, and his own restricted means, no farther advancement was made after his return, until June, 1840, when he secured his first patent, which was given on the specifications of April, 1838, for the rude instrument already described, including a second electro-magnet used to give an alarm, without the improvement up to the former date.

Unable to proceed further on a more extensive scale of experiment, he procured the support of prominent scientific men in a petition to Congress during the December Session of 1842. Prof. J. Henry, in a deposition made in March, 1850, states of Mr. Morse as follows:

"Shortly after my return from Europe, in the autumn of 1837, I learned that Mr. Morse was about to petition Congress for assistance in constructing the electro-magnetic telegraph; some of my friends in Princeton, knowing what I had done in developing the principles of the telegraph, urged me to make the representation to Congress, which I had expressed some thoughts of doing, namely, that the principles of the electro-magnetic telegraph belong to the science of the world, and that any appropriation which might be made by Congress, should be as a premium for the best plan, and the means of testing the same, which the ingenuity of the country might offer. Shortly after this, I visited New York, and there accidentally made the personal acquaintance of Mr. Morse. He appeared to be an unassuming and prepossessing gentleman, with very little knowledge of the general principles of electricity, magnetism, or electro-magnetism. He made no claims, in conversation with me, to any scientific discoveries, or to anything beyond his particular machine and process of applying known principles to telegraphic purposes. He explained to me his plan of a telegraph, with which he had recently made a successful experiment. I thought this plan better than any with which I had been made acquainted in Europe. I became interested in him, and instead of interfering with his application to Congress, I gave him a certificate in the form of a letter, stating my confidence in the practicability of the electro-magnetic telegraph, and my belief that the form proposed by himself was the best that had been published.

"Mr. Morse subsequently visited Princeton several times, to confer with me on the principles of electricity and magnetism, which might be applicable to the telegraph. I freely gave him any information which I possessed."

In respondence to his petition, Congress appropriated $30,000 for the purpose of testing its practical application. Thus enabled to prosecute his favorite theme with a freer element and more liberal spirit of investigation, he had the great gratification to exhibit to the American people his invention, working in an eminently successful manner, for a distance of forty miles, between the cities of Baltimore and Washington, in the month of June, 1844.

Prof. Morse has obtained for his instrument several distinct patents; the first was dated June 20, 1840; there were many important modifications introduced, such as a signal lever key substituted for the port rule, and a lever in the register in place of the pendulum, when it was exhibited before Congress, in 1838; this was re-issued January 15, 1846. A second patent was taken out on the 11th of April, 1846, containing the above alterations, with the addition of a local circuit and register, receiving magnet and adjuster, self-regulating break, the metal pen points, and grooved rollers for them to work in.

To be Continued.

On Steam Boilers and the Causes of their Explosion. *By* W. FAIRBAIRN, ESQ., C. E., F. R. S., &c.*

The following is an abstract of two lectures delivered by Mr. Fairbairn, on the 23d and 24th of April, at Leeds. The reputation of the author would be sufficient to secure for them the careful attention of practical men, even if recent sad occurrences had not roused the proprietors of steam boilers from the state of fatal indifference to the safety of their work people in which a large number of them seem buried. Great credit is due to Mr. Fairbairn for devoting his time and the results of his experience for the public advantage, and we are satisfied that this method of treating the subject will do more towards enlightening the public mind, and tend more to the prevention of boiler explosions, than any legal enactments that could be devised. The time of professional men is too valuable to them to admit of their giving their services gratuitously, but we think that government might well bestow such a sum annually as would provide for the public instruction upon such subjects as boiler and colliery explosions, sanatary measures, and the like.—*Ed. of the Artizan.*

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*From the London Artizan, for June, 1851.

I propose to consider the boiler in its *construction*, *management*, *security*, and *economy*.

1st. As to the construction. Here I shall have to go a little into detail, in order to show, in construction, the absolute necessity there exists for adhering to form and other considerations, essential in the practice of mechanical engineers, in effecting the maximum of strength with the minimum of material. In boilers this is the more important, as any increase in the thickness of the plates obstructs the transmission of heat, and exposes the rivets as well as the plates to injury on the side exposed to the action of the furnace.

It has generally been supposed that the rolling of boiler plate iron gives to the sheets greater tenacity in the direction of their length than in that of their breadth: this is, however, not correct; as a series of experiments which I made some years since, fully proves that there is no difference in the tensile strength of boiler plates when torn asunder in the direction of the fibre, or across it. From five different sorts of iron the following results were obtained:—

Description of Iron.	Mean breaking weight in tons in the direction of the fibre.	Mean breaking weight in tons across the fibre.
Yorkshire Plates	25·77	27·49
Yorkshire Plates	22·76	26·37
Derbyshire Plates	21·68	18·65
Shropshire Plates	22·82	22·00
Staffordshire Plates	19·56	21·01
Mean	22·51	23·10

From this it appears that we may safely use iron plates in the construction of boilers in whatever direction may best suit the convenience of the maker. Next to the tenacity of the plates, comes the question of riveting, or the best and surest means of securing them together. On this part of the subject we have been widely astray, and it required some skill and no inconsiderable attention in conducting the experiments, to convince the unreflecting portion of the public—and even some of our boiler makers—that the riveted joints were not stronger than the plate itself. At first sight, this would appear to be the case, but a moment's reflection will soon convince us to the contrary, as in punching holes along the edge of a plate it is obvious that the plate must be weakened to the extent of the sectional areas punched out, and that it is next to impossible, under the circumstances, to retain the same strength in the material after such diminution has been effected as existed in the previously solid plate. This was clearly demonstrated by a series of experiments which took place some years since, and in which the strength of almost every description of riveted joint was determined by tearing them directly asunder. The results obtained from these experiments were conclusive, as regards the relative strength of riveted joints and the solid plates. In two different kinds of joints—double and single riveted—the strengths were found to be, in the ratio of the plate as the numbers 100, 70, and 56.

Assuming the strength of the plate to be	100
The strength of a double riveted joint would be, after allowing for the adhesion of the surfaces of the plate	70
And the strength of a single riveted joint	56

These proportions of the relative strengths of plates and joints may therefore in practice be safely taken as the standard value, in the construction of vessels required to be steam and water tight, and subjected to pressure varying from 10 lbs. to 100 lbs. on the square inch.

In the construction of boilers exposed to severe internal pressure, it is desirable to establish such forms, and so to dispose the material, as to apply the greatest strength in the direction of the greatest strain; and in order to accomplish this, it will be necessary to consider whether the same arrangement be required for all diameters, or whether the form as well as the disposition of the plates should not be changed. To determine these questions in cylindrical boilers, recourse must be had to experiment, or such deduction as may apply to any given case, and such as is founded upon unerring data derived from experimental research. On this head I am fortunate in having before me the calculations of Professor W. R. Johnson, of the Franklin Institute of America, whose inquiries into the strength of cylindrical boilers are of great value, and from which the following short abstract may be useful.

"1st. To know the force which tends to burst a cylindrical vessel in the longitudinal direction, or, in other words, to separate the *head* from the curved *sides;* we have only to consider the actual area of the head, and to multiply the units of *surface* by the number of units of *force* applied to each superficial unit. This will give the total *divellent* force in that direction.

"To counteract this, we have, or may be conceived to have, the tenacity of as many longitudinal bars as there are lineal units in the circumference of the cylinder. The united strength of these bars constitutes the total retaining or *quiescent* force, and at the moment when rupture is about to take place, the *divellent* and the quiescent forces must obviously be equal.

"2d. To ascertain the amount of force which tends to rupture the cylinder along the curved side, or rather along the opposite sides, we may regard the pressure as applied through the whole breadth of the cylinder upon each lineal unit of the diameter. Hence the total amount of force which would tend to divide the cylinder in halves, by separating it along two lines, on opposite sides, would be represented by multiplying the diameter by the force exerted on each unit of surface, and this product by the length of the cylinder. But even without regarding the length, we may consider the force requisite to rupture a *single band* in the direction now supposed, and of one lineal unit in breadth; since it obviously makes no difference whether the cylinder be long or short, in respect to the ease or difficulty of separating the sides. The *divellent* force in this direction is therefore truly represented by the diameter multiplied by the pressure per *unit of surface.* The retaining or *quiescent* force, in the same direction, is only the strength or tenacity of the two opposite sides of the supposed band. Here also at a moment when a rupture is about to occur, the divellent force must exactly equal the quiescent force."

Mr. Johnson then goes on to show that as the diameter is increased, the product of the diameter and the force or pressure per unit of surface is increased in the same ratio. This truism I shall endeavor to prove; as also, that as the diameter of any cylindrical vessel is increased, the thickness of the metal must also be increased in the exact ratio of the increase of the diameter, the pressure, or, as Mr. Johnson calls it, the divellent force being the same; when the diameter of a boiler is increased, it must be borne in mind that the area of the ends is also increased, not in the ratio of the diameter, but in the ratio of the square of the diameter, and it will be seen that instead of the force being doubled, as is the case in the direction of the diameter and circumference, it is quadrupled upon the ends, or, what is the same thing, a cylinder double the diameter of another cylinder has to sustain four times the pressure in the longitudinal direction.

The retaining force or the thickness of the metal of a cylindrical boiler does not, however, increase in the same ratio as the area of the circle, but simply in the ratio of the diameter; consequently, the thickness of the metal will require to be increased in the same ratio as the diameter is increased. From this it appears that the tendency to rupture by blowing out the ends of a cylindrical boiler will not be greater in this direction than it is in any other direction; we may, therefore, safely conclude, since we have seen that the tendency to rupture increases in both directions in the ratio of the diameter, that any deviation from that law, as regards the thickness of the plates, would not increase the strength of the boiler.

I have been led to these inquiries from the circumstance that Mr. Johnson appears to reason on the supposition that there are no joints in the plates, and that the tenacity of the iron is equal to 60,000 lbs., rather more than 26 tons to the square inch. Now we have shown by the results of the experiments already adduced, that ordinary boiler plates will not bear more than 23 tons to the square inch, and as nearly one-third of the material is punched out for the reception of the rivets, we must still further reduce the strength, and take 15 tons, or about 34,000 lbs.* on the square inch, as the tenacity of the material, or the pressure at which a boiler would burst.

This I should consider in practice as the maximum power of resistance of boiler plates in their riveted state, and I will now trouble you to follow me in a very concise, and I trust not uninteresting investigation as to the bearing powers of boilers, and the pressure at which they can be worked with safety.

It has been stated that the strengths of cylindrical boilers, when taken in the direction of their circumference, are in the ratio of their diameters, and when taken in the direction of the ends, as the squares of the diameters, a proposition which it will not be difficult to demonstrate as applicable to every description of boiler of the cylindrical form. It will be seen, however, that the strain is not exactly the same in every direction, and that there is actually less upon the material in the longitudinal direction, than there is upon the circumference. For example, let us take two boilers, one three feet diameter and the other six feet, and suppose each to be subject to a pressure of 40 lbs. to the square inch. In this condition, it is evident that the area or number of square inches in the end of a three-feet boiler is to that of the area of the six-feet boiler as 1 to 4, and by a common process of arithmetic it will. be found that the edges of the plates forming the cylindrical part of the three-feet boiler is subject (at 40 lbs. on the square inch) to a pressure of 40,712 lbs.—upwards of 18 tons—whereas the plates of the six-feet boiler have to sustain a pressure of 162,848 lbs., or 72 tons, which is quadruple the force to which the boiler only one-half the diameter is exposed; and the circumferences being only as two to one, there is necessarily double the strain upon the cylindrical plates of the large boiler. Now this is not the case with the other parts of the boiler, as the circumference of a cylinder increases only in the ratio of the diameter; consequently the pressure, instead of being increased in the ratio of the squares of the diameter, as shown in the ends, is only doubled, the circumference of the six-feet boiler being twice that of the three-feet boiler.

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* By experiment it is found that the strength of the riveted joints of boilers is only about one-half the strength of the plate itself; but taking into consideration the crossing of the joints, 34,000 lbs. may reasonably be taken as the tenacity of the riveted plates, or the bursting pressure of a cylindrical boiler.

Let us, for the sake of illustration, suppose the two cylindrical boilers, such as we have described, to be divided into a series of hoops of one inch in width; and, taking one of these hoops in the three-foot boiler, we shall find it exposed at a pressure of 40 lbs. on the square inch, to a force of 1440 lbs., acting on each side of a line drawn through the axis of a cylinder 36 inches diameter, and 1 inch in depth, and which line forms the diameter of the circle. Now this force causes a strain upon any two points in the three feet circle of 720 lbs., and assuming the pressure to be increased till the force becomes equal to the tenacity or retaining powers of the iron, it is evident, in this state of the equilibrium of the two forces, that the least preponderance on the side of the internal pressure would insure fracture. And, suppose we take the plates of which the boiler is composed at one quarter of an inch thick, and the ultimate strength at 34,000 lbs. on the square inch, we shall have $\frac{34,000}{36 \times 2} = 472$ lbs. per square inch as the bursting pressure of the boiler. Again, as the forces in this direction are not as the squares, but simply as the diameter, it is clear that at 40 lbs. on the square inch, we have in a hoop an inch in depth, or that portion of a cylinder whose diameter is 6 feet, exactly double the force applied, as was acting in the diameter of 3 feet. Now, assuming the plates to be a quarter of an inch thick, as in the three-feet boiler, it follows, if the forces at the same pressure be doubled in the large cylinder, that the thickness of the plates must also be doubled in order to sustain the same pressure with equal security; or what is the same thing, the six-feet boiler must be worked at half the pressure, in order to secure the same degree of safety as attained in the three-feet boiler at double the pressure. From these facts it may be useful to know, that boilers having increased dimensions should also have increased strength in the ratio of their diameter; or, in other words, the plates of a six-feet boiler should be double the thickness of the plates of a three-feet boiler, and so on in proportion as the diameter is increased.

The relative powers of force applied to cylinders of different diameters become more strikingly apparent when we reduce them to their equivalents of strain per square inch, as applied to the ends and circumference of the boiler respectively. In the three-feet boiler, working at 40 lbs. pressure, we have a force equal to 720 lbs. upon an inch width of plate, and one quarter of an inch thick, or 720 by 4 equals 2880 lbs., the force per square inch upon every point of the circumference of the boiler.

Let us now compare this with the actual strength of the riveted plates themselves, which taken as before at 34,000 lbs. on the square inch, we arrive at the ratio of pressure as applied to the strength of the circumference as 2880 to 34,000, nearly as 1 to 12, or 472 per square inch, as the ultimate strength of the riveted plates.

These deductions appear to be true in every case as regards the resisting powers of cylindrical boilers, to a force radiating in every direction from its axis towards the circumference; but the same reasoning is, however, not maintained when applied to the ends, or, to speak technically, to the angle iron and riveting where the ends are attached to the circumference. Now, to prove this, let us take the three-feet boiler where we have 113 inches in the circumference, and upon this circular line of connexion we have, at 40 lbs. to the square inch, to sustain a pressure of 18 tons, which is equal to a strain of 360 lbs., acting longitudinally upon every inch of the circumference. Apply the same force to a six-feet boiler, with a circumference or line of connexion equal to 226 inches, and we shall find it exposed to exactly four times the force, or 72 tons; but in this case it must be borne in mind that the circumference is doubled, and consequently the strain, instead of being in the quadruple ratio, is only doubled, or a force equal to 720 lbs., acting longitudinally as before upon every inch of the circumference of the boiler. From these facts we come to the conclusion that the strength of cylindrical boilers is in the ratio of their diameters if taken in the line of curvature, and as the squares of the diameters as applied to the ends or their sectional area; and that all descriptions of cylindrical tubes, to bear the same pressure, must be increased in strength in the direction of their circumference simply as their diameters, and in the direction of the ends as the squares of the diameters.

Again, if we refer to the comparative merits of the plates composing cylindrical vessels, subjected to internal pressure, they will be found in this anomalous condition, that the strength in their longitudinal direction is twice that of the plates in the curvilinear direction. This appears by a comparison of the two forces, wherein we have shown that the ends of the three-feet boiler, at 40 lbs. internal pressure, sustain 360 lbs. of longitudinal strain upon each inch of a plate a quarter of an inch thick, whereas the same thickness of plates have to bear in the curvilinear direction a strain of 720 lbs. This difference of strain is a difficulty not easily overcome, and all that we can accomplish in this case will be to exercise a sound judgment in crossing the joints, the quality of the workmanship, and the distribution of the material. For the attainment of these objects, the following table, which exhibits the proportionate strength of cylindrical boilers from 3 to 8 feet in diameter, may be useful.

Table of equal strength in Cylindrical Boilers from 3 *to* 8 *feet diameter, showing the thickness of metal in each respectively, at a pressure of* 450 *lbs. to the square inch.*

Diameter of Boilers.		Bursting pressure — equivalent to the ultimate strength of the riveted joint — as deduced from experiment. 34,000 lbs. to the square inch.	Thickness of the plates in decimal parts of an inch.
Feet.	Inches.		
3	0	450 lbs.	·250
3	6		·291
4	0		·333
4	6		·376
5	0		·416
5	6		·458
6	0		·500
6	6		·541
7	0		·583
7	6		·625
8	0		·666

Boilers of the simple form, and without internal flues, are subjected only to one species of strain, but those constructed with internal flues are exposed to the same tensile force which pervades the simple form, and further, to the force of compression which tends to collapse, or crush the material of the internal flues. In the cylindrical boiler, with round flues, the forces are diverging from the central axis, as regards the outer shell, and converging as applied to every separate flue which the boiler contains.

These two forces in a steam boiler are in constant operation; the tendency of the one being to tear up the external plates and force out the ends, and the other to destroy the form and to force the material into the central area of the flues. These two forces operate widely different upon the resisting powers of the boiler, which taken in the direction of its exterior envelope has to resist a tensile strain operating in every direction from within, and the internal flues acting as an arch, offer a powerful resistance to compression from without. It might be instructive as well as interesting to exhibit the nature of these powers, and determine the law by which vessels of this description are retained in shape; but this can only be done by experiment, and as these experiments would have to be conducted upon a large scale, and with great accuracy, in order to arrive at satisfactory results, we must abandon the idea for the present, and content ourselves with such information as we already possess. At some future period I may possibly devote my attention to this subject; it is one of great importance, and a series of well conducted experiments would, I make no doubt, supply valuable data in the varied requirements of boiler construction, and their comparative powers of resistance to the united force of tension and compression.

From the existing state of our knowledge, we must rest satisfied with the fact, that the resisting powers of cylindrical flues to compression will be directly as their diameters, and we may therefore conclude that a circular flue, eighteen inches diameter, will resist double the pressure of one three feet diameter. Hence it follows that the resistance of wrought iron plates of the circular form is to the force of compression as their diameters—the same, but with greatly diminished powers—as compared with the resistance of wrought iron cylindrical plates to tension.

To show the amount of strain upon a high pressure boiler 30 feet long, 6 feet diameter, having two internal flues, each 2 feet 3 inches diameter, working at a pressure of 50 lbs. on the square inch, we have only to multiply the number of square feet of surface, 1030, exposed to pressure by 3·21, and we have the force of 3319 tons, which a boiler of these dimensions has to sustain. I mention this to show that the statistics of pressure, when worked out, are not only curious in themselves, but instructive as regards a knowledge of the retaining powers of vessels so extensively used, and on which the bread of thousands depends. To pursue the subject a little further, let us suppose the pressure to be at 450 lbs. on the square inch, which a well constructed boiler of this description will bear before it bursts, and we have the enormous force of 29,871, or nearly 30,000 tons, bottled up within a cylinder of 30 feet long, and 6 feet diameter.

This is, however, inconsiderable when compared with the locomotive, and some marine boilers, which from the number of tubes, present a much larger extent of surface to pressure. Locomotive engines are usually worked at 80 to 100 lbs. on the inch, and taking one of the usual construction, we shall find at 100 lbs. on the inch that it rushes forward on the rail with a pent up force, within its interior, of nearly 60,000 tons, which is rather increased than diminished at an accelerated speed.

In a stationary boiler charged with steam at a given pressure, it is evident that the forces are in perfect equilibrium, and the strain being the same in all directions, there will be no tendency to motion. Supposing, however, this equilibrium to be destroyed by accumulative pressure till rupture ensues; it then follows that the forces in one direction having ceased, the others in an opposite direction being active, would project the boiler from its seat with a force equal to that which is discharged through the orifice of rupture. The direction of motion would depend upon the position of the ruptured part: if in the line of the centre of gravity, motion would ensue in that direction; if out of that line, an oblique or rotary motion round the centre of gravity would be the result.

The velocity or quantity of motion produced in one direction would be equal to the intensity or quantity lost; and the velocity with which the body would move would be in the ratio of the impulsive force, or the quantity lost. Therefore, the quantity of motion gained by an exploded boiler in one direction, will be as its weight and the quantity lost in that direction. These definitions are, however, more in the province of the mathematician, and may easily be computed from well known formula on the laws of motion.

We now come to the rectangular forms, or flat surfaces, which are not so well calculated to resist pressure. Of these we may instance the firebox of the locomotive boiler, the sides and flues of marine boilers—the latter of which, by the bye, are now superseded by those of the tubular form—and the flat ends of the cylindrical boilers, and others of weaker construction.

The locomotive boiler is frequently worked up to a pressure of 120 lbs.

on the square inch, and at times when rising steep gradients, I have known the steam nearly as high as 200 lbs. on the inch. In a locomotive boiler subject to such an enormous working pressure, it requires the utmost care and attention on the part of the engineer to satisfy himself that the flat surfaces of the fire-box are capable of resisting that pressure, and that every part of the boiler is so nearly balanced in its powers of resistance as that when one part is at the point of rupture every other part is on the point of yielding to the same uniform force. This appears to be an important consideration in mechanical constructions of every kind, as any material applied for the security of one part of a vessel subject to uniform pressure, whilst another part is left weak, is so much material thrown away; and in stationary boilers, or in moving bodies, such as locomotive engines and steam vessels, they are absolutely injurious, at least so far as the parts are disproportionate to each other, and the extra weight when maintained in motion, becomes an expensive and unwieldy incumbrance. A knowledge of the strength of the materials used, judicious care, and the exercise of sound judgment in its distribution, are therefore some of the most essential qualifications of the practical engineer. Our limited knowledge, and defective principles of construction, are manifest from the numerous abortions which exist, and although I am free to communicate all that I know on this subject, I nevertheless find myself deficient in many of the requirements necessary for the attainment of sound principles of construction.

Reverting to the question more immediately under consideration, it is, however, essential to give the requisite security to those parts which, if left unsupported, would involve the public as well as ourselves in the greatest jeopardy.

The greater portion of the fire-boxes of locomotive boilers, as before noticed, have the rectangular form, and in order to economise heat and give space for the furnace, it becomes necessary to have an interior and exterior shell; that which contains the furnace is generally made of copper, firmly united by rivets, and the exterior shell, which covers the fire-box, is made of iron, and united by rivets in the same way as the copper fire-box. Now these plates would of themselves—unless supported by riveted stays—be totally inadequate to sustain the pressure. In fact, with one-tenth the strain, the copper fire-box would be forced inwards upon the furnace, and the external shell bulged outwards, and with every change of force these two flat surfaces would move backwards and forwards, like the sides of an inflated bladder, at the point of rupture. To prevent this, and give the large flat surfaces an approximate degree of strength with the other parts of the boilers, wrought iron or copper stays, one inch diameter, are introduced; they are first screwed into the iron and copper on both sides to prevent leakage, and then firmly riveted to the interior and exterior plates. These stays are about six inches asunder, forming a series of squares, and each of them will resist a strain of about fifteen tons before it breaks.

Let us now suppose the greatest pressure contained in the boiler to be 200 lbs. on the square inch, and we have $6 \times 6 \times 200 = 7200$ lbs., or $3\frac{1}{4}$ tons, the force applied to a square of 36 inches; now as these squares are supported by four stays, each capable of sustaining 15 tons, we have

$4 \times 15 = 60$ tons as the resisting powers of the stays; but the pressure is not divided amongst all the four, but each stay has to sustain that pressure, consequently the ratio of strength to the pressure will be as $4\frac{1}{2}$ to 1 nearly, which is a very fair proportion for the resisting power of that part.

We have treated of the sides, but the top of the fire-box and the ends have also to be protected, and there being no plate but the circular top of the boiler from which to attach stays, it has been found more convenient and equally advantageous to secure those parts by a series of strong wrought-iron bars, from which the roof of the fire-box is suspended, and which effectually prevents it from being forced down upon the fire. It will not be necessary to go into the calculations of those parts; they are when riveted to the dome or roof of sufficient strength to resist a pressure of 300 to 400 lbs. on the square inch. This is, however, generally speaking, the weakest part of the boiler, with the exception probably of the flat ends, above the tubes in the smoke-box, where they are not carefully stayed.

In the flat ends of cylindrical boilers, and those of the marine construction, the same rule applies as regards construction; and the due proportion of the parts, as in those of the locomotive boilers, must be closely adhered to. Every description of boiler used in manufactories, and also those on board of steamers, should in my opinion be constructed to a bursting pressure of 400 to 500 lbs. on the square inch, and locomotive engine boilers, which are subjected to a much severer duty, to a bursting pressure of 600 to 700 lbs.

It now only remains for me to state that internal flues, such as contain the furnace in the interior of the boiler, should be kept as near as possible to the cylindrical form; and as wrought iron will yield to a force tending to crush it of about one-half of what would tear it asunder, the flue should in no case exceed one-half the diameter of the boiler, and with the same thickness of plates it may be considered equally safe to the other parts. In fact, the force of compression is so different to that of tension, that I should advise the diameter of the internal flues to be in the ratio of 1 to $2\frac{1}{2}$ instead of 1 to 2 of the diameter of the boiler.

I will not trouble you with a description of the haycock, hemispherical, and wagon-shaped boilers—they are all bad as respects their powers of resistance, and ought to be entirely exploded. I shall congratulate the public when they disappear from the list of those constructions entitled to the confidence of the public, and the consideration of the man of science as well as the practical engineer.

In treating of this subject, I hope to show not only what *are* the probable causes of explosion, but what appears equally important, what *are not* the causes. So many theories (some of them exceedingly problematical) have been brought forward on the occasion of disastrous explosions, that it requires the utmost care and attention to circumstances before they are generally admitted. To acquire satisfactory evidence as to the precise condition of the boiler and furnaces before an explosion, is next to impossible, as most frequently the parties in charge, and from whose mismanagement and neglect we may in many cases date the origin of the occurrence, are the first to become the victims of their own indiscretion, and we can only judge from the havoc and devastation that ensues as to the immediate cause of the event.

From this it follows that, in many of the explosions on record, few if any, of the real circumstances of the case are made known, and we are left to draw conclusions from the appearance of the ruptured parts, and the terrific consequences which too frequently follow as a result. This want of evidence as to the precise condition of a boiler with all its valves and mountings, preceding an explosion, is much to be regretted, as it causes a degree of mystery to surround the whole transaction; and the vague and sometimes inaccurate testimony of witnesses, but too often baffles all attempts at research, and creates additional cause of alarm to all those exposed to the occurrence of similar dangers.

To be Continued.

For the Journal of the Franklin Institute.

Reply to the Remarks made by B. F. Isherwood, Esq., Chief Engineer, U. S. Navy, on Nystrom's Screw Propeller.

In the July number of the Journal, I find a long article, headed "Remarks on Nystrom's Screw Propeller," written by B. F. Isherwood, Esq., Chief Eng. U. S. Navy. With the permission of the Editor, I will claim the privilege of an answer—which self defence and common justice demand. J. W. Nystrom.

Mr. Isherwood asks, in his first remark, "What would be the nature of that loss of effect, if any existed? It would be shown in the *increased slip of the screw*, for the following reason: the water being thrown off radially in all directions from the axis, by the centrifugal force communicated to it by the revolving screw, there would be a vacuum about the axis, provided the centrifugal force forming the vacuum exceeded the force with which the surrounding water would flow in to fill it, and the resistance to the screw would be decreased in proportion to the extent of this vacuum; that is, the slip of the screw would be increased. *The loss of effect, therefore, due to this centrifugal force, would be furnished by the increased slip of the screw.* But if the water flowed into the vacuum as fast as it was formed, the resistance to the screw would evidently remain the same as though there were no centrifugal force in action; and this is what actually occurs in practice." This may be the fact with straight-bladed propellers, but not when the propeller is centripetal. The water flowing into the vacuum as fast as it forms, and immediately thrown out by the centrifugal force, it will act as if there were no centrifugal force. Let us look at it a little closer. Before the water comes in contact with the propeller, it has no movement; but as far as the propeller gives it movement, the effect is delivered to the water, no matter in what direction it may be.

The helicoid surface of the propeller blades acts to throw the water backwards in direction parallel to the centre line of the propeller; let its magnitude and direction be represented by the line *c b*, plate IX.; the centrifugal force of the water at the same time acts outwards in the direction of the radii; let the line *a c* represent its magnitude and direction, then the line *a b* will represent the magnitude and direction of the total effect delivered from the propeller. The line *c b* represents the useful effect acting to propel the vessel, and the line *a c* represents the useless effect caused by the centrifugal force. If this is not clear enough, I would ask, Is it possible that the propeller can give the water a motion without expending some of its effect? And if that motion of the water is useless in propelling the vessel, the effect expended on it must be lost, it may be litttle or much; this is in regard to the straight-bladed or common propellers.

I stated, in the specification of the centripetal propeller (Vol. XXI, p. 350,) that the effect which is gained by counteracting the centrifugal force will be found by the angle the centrifugal force is acting upon. It seems Mr. Isherwood has not examined if there exists such an angle; now the question is, whether the centrifugal force acts to propel the vessel, where the propeller is centripetal.

Let a plane cut the propeller through its centre line, the section of the blades will be a curved line of the same nature as the spiral which forms the generatrix for the screw; that is, the angles *v* are proportionable at the same distance from the centre, and depends on the centrifugal force (in straight bladed propellers this section will be a straight line in the direction of the radii).

When the propeller is revolving, the water between the blades is acted by the centrifugal force upon an inclined plane, represented by the section of the blades (see plate); let the line *a c* represent the magnitude and direction of the centrifugal force in the point *a*, draw through the point *a* the tangent *t b*, draw from the point *c* a line *c d* at right angles to *t b*, then the line *c d* represents the magnitude of a force acting at right angles on the inclined plane at the point *a*; from *d* draw a line *d e* at right angles to *a c*, *then the line* d e *represents the magnitude of the force useful to propel the vessel, and caused by the centrifugal force.* Were it necessary, words could be multiplied and pages filled in the elucidation of the subject; but enough for the present. Mr. Isherwood says: "Let it then be considered the depth to which the axis of a 13-feet (mean size) is immersed, and the consequent pressure of water about it; and then the slips found in practice, ranging from 15 to 30 per cent. for maximum, and it will be seen how erroneously the effect of any centrifugal force must be exaggerated, to make it productive of a vacuum at the axis of the screw." We will look at this a moment. Suppose a propeller of 13 feet in diameter (which Mr. Isherwood calls a mean size) making 65 revolutions per minute, and a mass of water weighing 50 pounds revolve with the propeller in the periphery, the centrifugal force will be

$$C=\frac{4\times 3{\cdot}14^2\times 65^2\times 6{\cdot}5\times 50}{32{\cdot}2\times 60^2}=470 \text{ pounds;}$$

the upward pressure of that 50 lbs. of water at the depth of 13 feet will be

$$\sqrt[3]{\left.\frac{50}{0{\cdot}785\times 62{\cdot}5}\right)^{2}}\times 0{\cdot}785\times 62{\cdot}5\times 6{\cdot}5=322 \text{ pounds.}$$

consequently, the centrifugal force is sufficient to make a vacuum in the centre of the propeller, because the centrifugal force is 148 pounds more than the upward pressure; here the slip is not taken into consideration;

then the centrifugal force will be less. But instead of that, the centrifugal force is multiplied within the entire extremity of the periphery of the propeller; the flowing in of the water to fill up the vacuum occurs only in the centre, or around the hub, and there the stern post occupies considerable space.

But if the centrifugal force is not sufficient to cause a perfect vacuum in the hub of the propeller, it is sufficient to give the water a corresponding *irregular* and *useless motion*, which is proved to be a loss of effect.

Mr. Isherwood says: "With a straight generatrix touching the axis, the lateral component of the oblique surface of the screw is tangential to a cylinder," &c. What has this to do with the centrifugal force? But if that is the reason why the centrifugal force acts as if there was no centrifugal force, the Chief Engineer's philosophy is certainly above the comprehension of common minds.

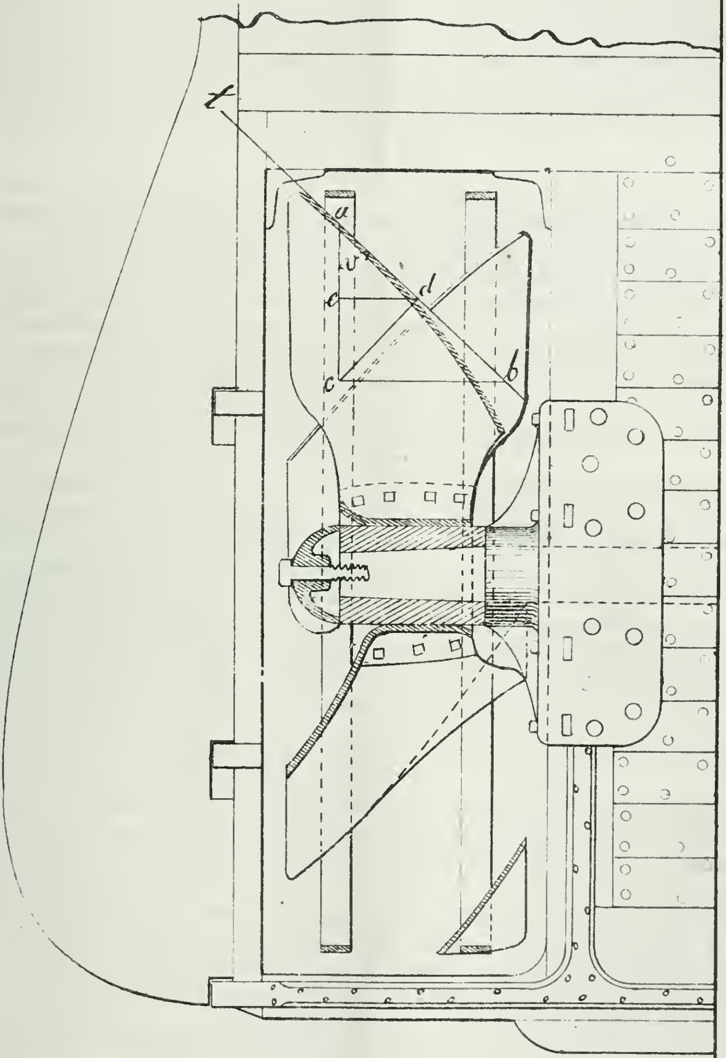
Again, Mr. Isherwood says: "The same slip, or, in other words, the same resistance is obtained from the water, with screws of equal diameter, pitch, and length, whether they have straight, inclined, or curved generatrices; for the curved generatrix is obviously but a modification of the inclined generatrix." *Only a modification of the generatrix.* That is no reason at all why the propeller should act equal in the water, if making the screw of iron and the nut also of iron, when screwed together, it will act equal with any generatrix of the screw. But the action of the propeller in the water is different; the resistance I have proved, in the foregoing, that by counteracting the centrifugal force, an additional resistance$=d\ e$ will be gained (see plate,) and acts direct in propelling the vessel.

Mr. Isherwood further states: "It is an inclined generatrix, whose inclination momentarily changes. It is therefore governed by the same principles." Of course it is; I did not say it was on any other principle. Mr. I. speaks of "the practical disadvantage and loss of labor attending the use of a curved generatrix, though none theoretically." Is it the manual labor required in making the propeller? or is it the manual labor to use the propeller when it is in the water? or is it the labor of the engine which is lost? On what principle can it be proved that the friction is greater in curved bladed propellers; and if it is so, does it not prove that the resistance is greater in propelling the vessel? Mr. Isherwood says: "Believing that sufficient has been written to put this subject in a true light," &c. We are obliged to the U. S. Chief Engineer for the *clearness* of his light, and sincerely hope its brilliancy will not serve only to make darkness visible; and as he finds it needful for the further enlightenment of the readers of the *Journal*, to notice only a few of our statements, we will listen patiently to the conclusion of the whole matter.

First, that the "water forced backwards by the blades of the screw is in directions at right angles to the surface of those blades." I did not say any such thing in my specification. I did say *in direction parallel to the axis of the propeller;* not in direction at right angles to the surface of those blades; but if I had, that does not change the shape or operation of the propeller.

Mr. Isherwood quotes my statements in regard to ocean steamers; he

NYSTROM'S CENTRIPETAL SCREW PROPELLER.



says, I give the slip of screw propellers for ocean steamers at 50 per cent.; I did not say it was a general rule; it can be more or less; but in the proportion I give of tonnage, greatest section, area, and diameter of propeller, which the slip is dependent upon, it will be so.

Mr. Isherwood gives the slip at 25 or 30 per cent. as maximum, without any regard to the quantities the slip is dependent upon; that will do very well in talking about propellers, but the facts are different. Mr. I. was very careful not to say anything about canal boats and tow boats.

The slip will be found very nearly by the following formulæ:

$$\text{Slip} = \frac{A + \sqrt[3]{D^2}}{x\,a},$$

in which A denotes the greatest section area of the displacement in square feet, D denotes the displacement in tons, and a the area for the propeller in square feet; x is a coefficient depending on the quality of the propeller, and varying between 8 and 12 or thereabout; that is, the best propeller takes the highest number.

But whatever the slip may be, the formula by which the curve is obtained, gives a corresponding shape to the propeller blades, in order to counteract the centrifugal force.

Mr. Isherwood gives a long article about the bands around the propeller:—

In practice, we need not go so deep into the philosophy of the bands; they are not at all for that purpose, as Mr. Isherwood imagines. As the blades (on the centripetal propeller) are curved, the resistance of the water acts to straighten the blades, and of course acts to give the propeller a larger diameter, which might not be allowed in the determined space for the propeller. For that purpose, a pair of bands of the same thickness as the propeller blades is sufficiently strong; and if the blades meet with any obstacle in the water, the bands serve to keep the blades in their proper position; they are really a necessary and worthy appendage to a centripetal screw propeller.

Only when the propeller is made of cast iron, or very small of wrought iron, the bands can be dispensed with.

I have a propeller, made at Gloucester Iron Works, only six feet in diameter; the wrought iron is half-inch thick at the hub, and considered sufficiently strong *without* bands; and I did not recommend them as being of great utility.

The generatrix Mr. Isherwood speaks of, must be the spiral, which is generated by warping a determined line around the circumference of a circle, called the *circles evolute*: but whatever he means, it must be different from what I have described in the specification, about the centripetal propeller, because that generatrix (spiral) has nothing to do with the tangent of an inner cylinder.

Of the experiments of which Mr. I. speaks, I would say, the generatrix to the propeller could not be calculated after the centrifugal force or velocity of the propeller. Mr. I. says: "The generatrix was tangent to an inner cylinder." Such a generatrix can not correspond with the centrifugal force, *therefore quite different from my propeller.* A fact which proves that Mr. I has not fully examined my propeller.

I do not doubt experiments with such a generatrix would be most unsatisfactory, and it frequently happens that experiments give far different results from what was anticipated, owing to disarrangements not always fully understood.

As this is a subject of some interest, we will consider it practically. To any who feel disposed to satisfy themselves of the utility of a centripetal propeller, I will furnish one of any size, at the same rate as a common propeller; and if it does not fully answer, will refund the money.

Philadelphia, July 22d, 1851.

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*Interesting and Unprecedented Test of Chains and Iron Rods.**

J. Foster, Esq., and the Rev. J. B. Owen, of Bilston, G. R. Hickman, Esq., of Tipton, and several other gentlemen interested in scientific experiments, attended at the cable manufactory of Mr. H. P. Parkes, Dudley, to witness some extraordinary tests of the strength and toughness of iron used in the fabrication of chains. When any one considers the frightful loss of life so frequently the result of the breaking of a single link in a chain, or the failure of a girder in an iron roof, the importance of any decided improvement in the metal and workmanship employed for such purposes cannot be too highly appreciated. Several samples of round chains, of $\frac{5}{8}$ of an inch size, were put to the hydraulic proof, and whereas the interstices between the links, previous to their tension, measured only the $\frac{1}{32}$ of an inch, after proof it had stretched equally, even without loss of symmetry in shape, to $\frac{15}{16}$ inch. One of these pieces of $\frac{5}{8}$ inch chain sustained without a flaw, 18·10 tons, being nearly four times the ordinary testing weight. It is due to the enterprising and intelligent experimentalist, Mr. Millington, of the firm of Messrs. W. Millington and Co., Summerhill Iron Works, Tipton, to state that of all the qualities of iron submitted to the proof, the material furnished from his works stood the severest test. Its fabric is a novelty to the trade, and will be shortly patented. Mr. Parkes has contributed a sample board of chain to the Great Exhibition, in sizes varying from $\frac{1}{4}$ to $2\frac{1}{2}$ inches, which have been tested by unprecedented proof, at his factory at Tipton. This series of experiments, probably of some importance to the Staffordshire trade, terminated, not unnaturally, with the tying-in iron of "the Staffordshire Knot." A piece of $\frac{5}{8}$ inch round of Mr. Millington's iron, formed into a nose at each end, and gracefully formed into a loose tie, was drawn in cold metal into a tight compact knot, lifting in the process the unparalleled weight of 8 tons. The chains seemed elastic as gutta percha, and stretched to nearly double their length during the proof, and like metal paralyzed, became rigid, and straight as an iron bar.

Convolute Boiler.—Registered for MESSRS. GARTON & JARVIS, *Exeter.*†

This boiler is intended for heated conservatories or public buildings by steam, or the circulation of hot water. Our engraving represents the boiler in perspective, with the fire-doors removed. The boiler, A, is of the convolute form, having the grate-bars, B, within it. It is made either of wrought or cast iron, or copper, the water space between the two parallel sheets of metal forming the volute, being three inches in breadth. The course of the draft is very obvious; it passes from the interior of the convolute out by the open overlap, and then completely round the exterior of the boiler, which is surrounded by brick-work to form the external flue. The pipe, C, forms the water communication between the body of the boiler and the crown. The heated current of water flows off to the locality to be warmed, by the pipe, D, and the heavier cooled water returns by the bottom pipe, E. It will be seen that the peculiar feature of this arrangement, is the effective mode in which the entire internal and external surfaces are exposed to the action of the heat. Several boilers on this principle are in the exhibition.

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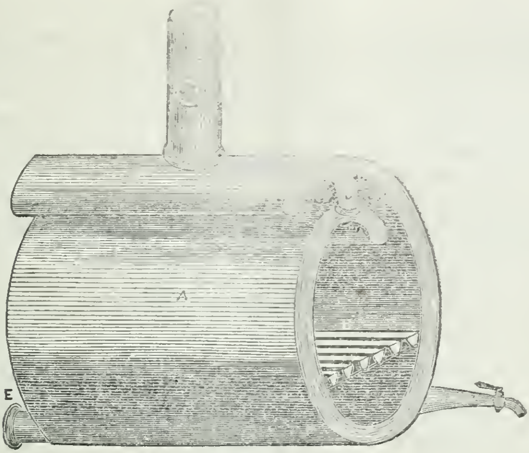
* From the London Mining Journal, No. 822.

† From the Glasgow Practical Mechanic's Journal, June, 1851.



FRANKLIN INSTITUTE.

Proceedings of the Stated Monthly Meeting, July 17, 1851.

S. V. Merrick, President, in the chair.

Isaac B. Garrigues, Recording Secretary.

The minutes of the last meeting were read and approved.

Donations were received from The Royal Astronomical Society, London; The Smithsonian Institute, and R. P. Anderson, Esq., Washington City, D. C.; Simeon Borden, Esq., Fall River, Massachussetts; Jordan L. Mott, Esq., City of New York; S. H. Palairet, Esq., George Harding, Esq., Charles E. Smith, Esq. and the Pennsylvania Railroad Company, Philadelphia.

The Periodicals received in exchange for the Journal of the Institute were laid on the table.

The Treasurer's statement of the receipts and payments for the month of June was read.

The Board of Managers and the Standing Committees reported their minutes.

The Board of Managers reported that at their last meeting they re-appointed Mrs. Sarah Peter, Mrs. S. V. Merrick, Miss Ellen Lawson, and Messrs. S. V. Merrick, D. S. Brown, and Frederick Fraley, the Committee on the School of Design for Women, for the ensuing year.

New candidates for membership in the Institute (3) were proposed, and the candidate proposed at the last meeting was duly elected.

Mr. Walcott, of Boston, exhibited Robinson's back-stitch sewing machine, in operation before the meeting, which excited much admiration from the members present, and made the following remarks:

This useful machine was patented in December, 1850. The object of the invention is to produce either what is generally termed, stitch and back stitch sewing or ordinary stitching, but this machine not only sews the regular back stitch, but with slight mechanical adjustment, the basting, whipping, quilting, and cordwainers. There is a combination of two needles, two thread guides, and a cloth-holder, made to operate together, each needle having a spring to which pressureis applied in passing through, which spring retains the thread. The whole is worked by a wheel which governs and regulates the motion, with a handle on the wheel, which could be turned by a child; the whole apparatus showing great mechanical skill and ingenuity.

The advantages claimed for this machine over all others, are the durability and the fastness of the stitch; the perfect simplicity and compactness of machinery, and the many purposes to which it can be applied. The stitch taken by this machine is a fac simile of hand sewing, consequently it can be successfully applied to the same purposes. It also possesses many advantages even over hand sewing, which the practical tailor admits. The sewing produced is more accurate, makes a firmer seam, and is more durable than that done by hand. In hand sewing, at intervals of stitches, the thread remains loose, and therefore, allows the stitch taken to slack, which we overcome by keeping the thread continually tight by means of thread holders, which act in the capacity of fingers. In seaming clothing with silk, it is very necessary that the silk should be waxed to give a firm seam. It is well known that all kinds of silk will stretch about one inch in ten. This machine will work the silk waxed, as well as without.

An interesting relic in the form of a musket was presented to the Institute by Jordan L. Mott, Esq., of New York, obtained from the wreck of the British Frigate Hussar, which was sunk in about 75 feet water, 1½ miles from Hurl Gate, East River, Nov. 14th, 1780. The brass was in the most perfect state of preservation, whilst the barrel, lock and screws, were reduced to the state of oxide.

JOURNAL

OF

THE FRANKLIN INSTITUTE

OF THE STATE OF PENNSYLVANIA

FOR THE

PROMOTION OF THE MECHANIC ARTS.

SEPTEMBER, 1851.

CIVIL ENGINEERING.

On the Nominal Horse Power of Steam Engines. *By* COMMANDER L. G. HEATH, R. N.*

The inadequacy of the present term "nominal horse power" for giving a definite idea of either the absolute or relative power of engines was first examined, by comparing the engines of H. M. steamships Garland and Basilisk, which were both constructed on the same principle, with oscillating cylinders, and were both used to drive paddle wheels. This comparison was made under three distinct heads,—the mean effective pressure, the number of revolutions per minute, and the size of the cylinders. It was urged that Watt's constant of seven pounds per square inch, for the mean effective pressure, was not only in itself inapplicable, but that no constant quantity could be universally applicable. Also, that the method of determining the number of revolutions per minute, from a conventional speed, founded on the length of stroke of the piston, was equally fallacious. It was therefore proposed, that the term "nominal horse power" should be abolished; and that engines should in future be designated by the cubic contents of their steam cylinders, jointly with their nominal consumption of a standard description of fuel during a given period of one hour. A table might be drawn up giving this nominal consumption in terms of the grate and the heating surface, and should be accompanied by rules and directions for ensuring the uniform measurement of the grate and the heating surface. This system, it was contended, would be more in accordance with the present practice of construction, and would enable the relative size and power of engines to be more accurately estimated than by the present method.—*Proc. Insti. Civ. Eng., April* 8, 1851.

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* From the London Athenæum, April 8, 1851.

It was admitted that it would be very desirable to fix the nomenclature of the power of engines; for though it was well known that James Watt did really take as his standard, what he found to be actually performed by a powerful horse drawing a weight over a pulley,—viz: the equivalent of 33,000 lbs. raised one foot high in a minute—yet commercially it had gradually become a custom among the manufacturers to give a surplus of power, ostensibly as an allowance for the friction and deficiencies of the machine, so that now, the mere statement of the nominal horse power had no definite meaning. It was, however, contended that the standard of 33,000 lbs. should be retained; and that, supposing the workmanship to be equally good in two engines, it was only necessary to compare the areas of the cylinders, the effective pressure of steam on the piston, and the speed of the piston, to determine their relative power. This was, in fact, shown by the indicator, an instrument the value of which was now universally admitted, and which, when skilfully used, did really give a true representation of the power of the engine. It was the universal custom of Boulton and Watt to calculate the power exerted by an engine by the speed of the piston, together with the average pressure of the steam, as shown by the indicator; and although much vagueness and uncertainty had latterly been introduced into the subject, this was rather to be attributed to the assumption of arbitrary quantities to represent those results, than to any defect in Watt's standard horse-power, which definitely expressed both the measure of power and the space through which it acted. The proposed standard of comparison of the quantity of water evaporated in a given time, by a given amount of fuel, or the combustion of a given quantity of fuel in a given time, were shown to be of no value; as then not only the generation of the steam, but the administration of it, must be considered, and these were points merely tending to complicate the question. For pumping engines in Cornwall, the term horse-power, was almost unknown, engines being sold to raise a given quantity of water, which was a standard easily reducible to that of other districts, where 33,000 lbs. was assumed to be the actual power of a horse.—*Proc. Inst. Civ. Eng.*, *April* 15, 1851.

For the Journal of the Franklin Institute.

A New Method of Calculating the Cubic Contents of Excavations and Embankments.—By John C. Trautwine, C. E.

Entered, according to the Act of Congress, in the year 1851, by John C. Trautwine, in the Clerk's Office of the District Court of the United States, for the Eastern District of Pennsylvania.

Continued from page 88.

In the following tables of level cuttings, the left hand vertical column contains the height or depth of the embankment or excavation, in feet; and the upper horizontal column, the intermediate tenths of a foot. Thus in table 1, the cubic yards in a station 100 feet long and 10 feet deep, are 1074; for 10·1 deep, 1090; for 10·2 deep, 1107, &c.

TABLE 9.—LEVEL CUTTINGS.

Roadway 28 feet wide, side-slopes 1½ to 1.

Depth in ft.	·0	·1	·2	·3	·4	·5	·6	·7	·8	·9
	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.
0		10·4	21·0	31·6	42·1	53·2	64·2	75·3	86·5	97·9
1	109·3	120·8	132·5	144·3	156·1	168·1	180·2	192·4	204·8	217·2
2	229·6	242·3	255·0	267·9	280·9	294·0	307·2	320·5	334·0	347·5
3	361·2	374·9	388·8	402·8	416·9	431·1	445·4	459·9	474·4	489·1
4	503·7	518·6	533·6	548·6	563·9	579·3	594·7	610·2	625.8	641·6
5	657·5	673·4	689·5	705·7	722·1	738·5	755·0	771·7	788·4	805·3
6	822·2	839·3	856·5	873·8	891·2	908·8	926·4	944·2	962·0	980·0
7	998·1	1016	1035	1053	1072	1090	1109	1128	1147	1166
8	1185	1204	1224	1243	1263	1283	1303	1322	1343	1363
9	1383	1403	1424	1445	1465	1486	1507	1528	1549	1571
10	1592	1614	1635	1657	1679	1701	1723	1745	1767	1790
11	1812	1835	1858	1881	1904	1927	1950	1973	1997	2020
12	2044	2068	2092	2116	2140	2164	2189	2213	2238	2262
13	2287	2312	2337	2362	2387	2413	2438	2464	2489	2515
14	2541	2567	2593	2619	2645	2672	2698	2725	2752	2779
15	2806	2833	2860	2887	2915	2942	2970	2997	3026	3053
16	3081	3109	3138	3166	3195	3223	3252	3281	3310	3339
17	3368	3397	3427	3456	3486	3516	3546	3576	3606	3636
18	3667	3697	3728	3758	3789	3820	3851	3882	3913	3944
19	3976	4007	4039	4070	4102	4134	4166	4198	4231	4263
20	4296	4328	4361	4394	4427	4460	4493	4527	4560	4594
21	4627	4661	4695	4729	4763	4797	4832	4866	4900	4935
22	4970	5005	5040	5075	5111	5146	5181	5217	5253	5288
23	5324	5360	5396	5433	5469	5505	5542	5578	5615	5652
24	5689	5726	5763	5800	5838	5875	5913	5951	5989	6027
25	6065	6103	6141	6179	6218	6257	6295	6334	6373	6412
26	6451	6491	6530	6570	6609	6649	6689	6729	6769	6809
27	6850	6890	6931	6971	7012	7053	7094	7135	7176	7217
28	7259	7300	7342	7384	7426	7468	7510	7552	7594	7637
29	7680	7722	7765	7808	7851	7894	7937	7981	8024	8067
30	8111	8155	8199	8243	8287	8331	8375	8420	8464	8509
31	8554	8598	8643	8688	8734	8779	8824	8870	8915	8961
32	9007	9053	9099	9145	9191	9238	9284	9331	9378	9425
33	9472	9519	9566	9613	9661	9708	9756	9804	9851	9900
34	9948	9997	10045	10093	10142	10190	10239	10288	10337	10386
35	10435	10484	10534	10583	10633	10683	10733	10782	10832	10882
36	10933	10983	11034	11084	11135	11186	11237	11288	11339	11391
37	11443	11494	11546	11598	11649	11701	11753	11806	11858	11910
38	11963	12016	12068	12121	12174	12227	12281	12334	12387	12441
39	12494	12581	12602	12656	12710	12764	12819	12873	12928	12982
40	13037	13092	13147	13202	13257	13312	13368	13423	13479	13535
41	13591	13647	13703	13759	13815	13872	13928	13985	14042	14099
42	14156	14213	14270	14327	14385	14442	14500	14558	14615	14673
43	14731	14790	14848	14906	14965	15024	15082	15141	15200	15259
44	15318	15378	15437	15497	15556	15616	15676	15736	15796	15856
45	15917	15977	16038	16098	16159	16220	16281	16342	16403	16465
46	16526	16587	16649	16711	16773	16835	16897	16959	17021	17084
47	17146	17209	17272	17335	17398	17461	17524	17587	17651	17714
48	17778	17842	17905	17969	18033	18098	18162	18226	18291	18356
49	18420	18485	18550	18615	18680	18746	18811	18877	18942	19008
50	19074	19140	19206	19272	19339	19405	19472	19538	19605	19672
51	19739	19806	19873	19940	20008	20075	20143	20211	20279	20347
52	20415	20483	20551	20620	20688	20757	20826	20894	20963	21032
53	21102	21171	21241	21310	21380	21450	21519	21589	21659	21730
54	21800	21870	21941	22012	22082	22153	22224	22295	22366	22438
55	22509	22581	22652	22724	22796	22868	22940	23012	23085	23157
56	23230	23302	23375	23448	23521	23594	23667	23741	23814	23888
57	23961	24035	24109	24183	24257	24331	24405	24480	24554	23629
58	24704	24779	24854	24929	25004	25079	25155	25230	25306	25381
59	25457	25533	25609	25686	25762	25838	25915	25992	26068	26145
60	26222	26299	26376	26454	26531	26609	26686	26764	26842	26920

For continuation to 100 feet see table 13.

TABLE 10.—LEVEL CUTTINGS.

Roadway 28 feet wide, side-slopes 2 to 1.

Depth in ft.	·0	·1	·2	·3	·4	5.	·6	·7	·8	·9
	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.
0		10·4	21·0	31·8	42·7	53·7	64·9	76·2	87·7	99·3
1	111·1	123·0	135·1	147·3	159·7	172·2	184·9	197·7	210·7	223·8
2	237·0	250·4	264·0	277·7	291·6	305·6	319·7	334·0	348·4	363·0
3	377·8	392·7	407·7	422·9	438·2	453·7	469·3	485·1	501·0	517·1
4	533·3	519·7	566·2	582·9	599·7	616·6	633·7	651·0	668·4	686·0
5	703·7	721·5	739·5	757·7	776·0	794·4	813·0	831·7	850·6	869·6
6	888·9	908·2	927·7	948·3	968·1	988·1	1008	1028	1049	1069
7	1090	1111	1132	1153	1174	1195	1217	1239	1260	1282
8	1305	1327	1349	1372	1394	1417	1440	1464	1487	1510
9	1533	1557	1581	1605	1629	1654	1678	1703	1728	1753
10	1778	1803	1828	1854	1880	1905	1931	1958	1984	2010
11	2037	2064	2091	2118	2145	2172	2200	2227	2255	2283
12	2311	2339	2368	2396	2425	2454	2483	2512	2541	2570
13	2600	2630	2659	2689	2720	2750	2780	2811	2842	2873
14	2904	2935	2966	2998	3029	3061	3093	3125	3157	3190
15	3222	3255	3288	3321	3354	3387	3420	3454	3488	3521
16	3555	3590	3624	3658	3693	3728	3763	3798	3833	3868
17	3904	3939	3975	4011	4047	4083	4120	4156	4193	4230
18	4267	4304	4341	4378	4416	4454	4492	4529	4568	4606
19	4644	4683	4722	4761	4800	4839	4878	4918	4957	4997
20	5037	5077	5117	5158	5198	5239	5280	5321	5362	5403
21	5444	5486	5528	5570	5612	5654	5696	5738	5781	5824
22	5867	5910	5953	5996	6040	6083	6127	6171	6215	6259
23	6303	6348	6393	6438	6483	6528	6573	6618	6664	6710
24	6756	6802	6848	6894	6941	6987	7034	7081	7128	7175
25	7222	7270	7317	7365	7413	7461	7509	7558	7606	7655
26	7704	7753	7802	7851	7900	7950	8000	8049	8099	8150
27	8200	8250	8301	8352	8403	8454	8505	8556	8608	8659
28	8711	8763	8815	8867	8920	8972	9025	9078	9131	9184
29	9237	9290	9344	9398	9451	9506	9560	9614	9668	9723
30	9778	9833	9888	9943	9998	10054	10109	10165	10221	10277
31	10333	10390	10446	10503	10560	10617	10674	10731	10788	10846
32	10904	10961	11019	11078	11136	11194	11253	11312	11371	11430
33	11489	11548	11608	11667	11727	11787	11847	11907	11968	12028
34	12089	12150	12211	12272	12333	12394	12456	12518	12580	12642
35	12704	12766	12828	12891	12954	13017	13080	13143	13206	13270
36	13333	13397	13461	13525	13589	13654	13718	13783	13848	13913
37	13978	14043	14108	14174	14240	14305	14371	14438	14504	14570
38	14637	14704	14770	14838	14905	14972	15040	15107	15175	15243
39	15311	15379	15448	15516	15585	15654	15723	15792	15861	15930
40	16000	16070	16140	16210	16280	16350	16420	16491	16562	16633
41	16704	16775	16846	16918	16989	17061	17132	17205	17277	17350
42	17422	17495	17568	17641	17714	17787	17860	17934	18008	18081
43	18156	18230	18304	18378	18453	18528	18603	18678	18753	18828
44	18904	18979	19055	19131	19207	19283	19360	19436	19513	19590
45	19667	19744	19821	19898	19976	20054	20132	20210	20288	20366
46	20444	20523	20602	20681	20760	20839	20918	20998	21077	21157
47	21237	21317	21397	21478	21558	21639	21720	21801	21882	21963
48	22044	22126	22208	22290	22372	22454	22536	22618	22701	22784
49	22867	22950	23033	23116	23200	23283	23367	23451	23535	23619
50	23704	23788	23873	23958	24043	24128	24213	24298	24384	24470
51	24556	24642	24728	24814	24900	24987	25074	25161	25248	25335
52	25422	25510	25597	25865	25773	25861	25949	25033	26126	26215
53	26304	26393	26482	26571	26660	26750	26840	26930	27020	27110
54	27200	27290	27381	27472	27563	27654	27745	27836	27928	28019
55	28111	28203	28295	28387	28480	28572	28665	28758	28851	28944
56	29037	29130	29224	29318	29412	29506	29600	29694	29788	29883
57	29978	30073	30168	30263	30358	30454	30549	30645	30741	30837
58	30933	31030	31126	31223	31320	31417	31514	31611	31708	31806
59	31904	32002	32100	32198	32296	32394	32493	32592	32691	32790
60	32889	32988	33088	33187	33287	33387	33487	33587	33688	33788

For continuation to 100 feet see table 13.

TABLE 11.—LEVEL CUTTINGS.

Roadway 18 *feet wide, side-slopes,* ¼ *to* 1.

Depth in ft.	·0	·1	·2	·3	·4	·5	·6	7.	·8	·9
	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.
0		6·68	13·4	20·1	26·8	33·6	40·3	47·1	53·9	60·8
1	67·6	74·5	81·3	88·2	95·1	102·1	109·0	116·0	123·0	130·0
2	137·0	144·1	151·1	158·2	165·3	172·4	179·5	186·7	193·9	201·0
3	208·2	215·5	222·7	230·0	237·2	244·5	251·9	259·2	266·5	274·0
4	281·5	288·9	296·3	303·8	311·3	318·8	326·3	333·8	341·3	348·9
5	356·5	364·1	371·7	379·3	387·0	394·7	402·4	410·1	417·8	425·6
6	433·3	441·1	448·9	456·7	464·6	472·5	480·3	488·2	496·1	504·1
7	512·0	520·0	528·0	536·0	544·1	552·1	560·2	568·3	576·4	584·0
8	592·6	600·8	608·9	617·1	625·3	633·6	641·8	650·1	658·4	666·7
9	675·0	683·3	691·7	700·1	708·5	716·9	725·3	733·8	742·3	750·7
10	759·3	767·8	776·3	784·9	793·5	802·1	810·7	819·3	828·0	836·7
11	845·4	854·1	862·8	871·6	880·3	889·1	897·9	906·7	915·6	924·4
12	933·3	942·2	951·1	960·1	969·0	978·0	987·0	996·0	1005	1014
13	1023	1032	1041	1050	1060	1069	1078	1087	1096	1106
14	1115	1124	1133	1143	1152	1161	1171	1180	1189	1199
15	1208	1218	1227	1237	1246	1256	1265	1275	1284	1294
16	1304	1313	1323	1333	1342	1352	1362	1372	1381	1391
17	1401	1411	1421	1430	1440	1450	1460	1470	1480	1490
18	1500	1510	1520	1530	1540	1550	1560	1570	1580	1591
19	1601	1611	1621	1631	1642	1652	1962	1672	1683	1693
20	1703	1714	1724	1735	1745	1755	1766	1777	1787	1798
21	1808	1818	1829	1840	1850	1861	1872	1883	1894	1905
22	1916	1926	1937	1947	1958	1969	1980	1991	2002	2013
23	2024	2035	2046	2057	2068	2079	2090	2101	2111	2122
24	2133	2144	2156	2167	2178	2189	2200	2212	2223	2234
25	2245	2256	2268	2279	2290	2301	2313	2324	2336	2347
26	2359	2371	2382	2394	2406	2417	2429	2440	2452	2464
27	2475	2483	2498	2510	2521	2533	2545	2557	2569	2581
28	2592	2604	2616	2628	2640	2652	2664	2676	2688	2700
29	2712	2724	2736	2748	2760	2772	2784	2797	2809	2821
30	2833	2845	2858	2870	2882	2894	2907	2919	2931	2944
31	2956	2969	2981	2994	3006	3018	3031	3044	3056	3069
32	3081	3694	3107	3119	3132	3145	3157	3170	3183	3195
33	3208	3221	3234	3247	3260	3272	3285	3298	3311	3324
34	3337	3350	3363	3376	3389	3402	3415	3428	3441	3454
35	3467	3481	3494	3507	3520	3533	3547	3569	3573	3587
36	3600	3613	3627	3640	3653	3667	3680	3694	3707	3721
37	3734	3748	3761	3775	3788	3802	3816	3829	3843	3857
38	3870	3884	3898	3911	3925	3939	3953	3967	3980	3994
39	4008	4022	4036	4050	4064	4078	4092	4106	4120	4134
40	4148	4162	4176	4190	4208	4219	4233	4247	4261	4275
41	4290	4304	4318	4333	4347	4361	4376	4390	4404	4419
42	4433	4448	4462	4477	4491	4506	4520	4535	4549	4564
43	4579	4593	4608	4623	4637	4652	4667	4681	4696	4711
44	4726	4741	4756	4770	4785	4800	4815	4830	4845	4860
45	4875	4890	4905	4920	4935	4950	4965	4989	4995	5911
46	5026	5911	5056	5071	5987	5102	5117	5133	5148	5163
47	5179	5194	5209	5225	5240	5256	5271	5287	5302	5318
48	5333	5349	5364	5380	5396	5411	5427	5443	5458	5474
49	5490	5505	5521	5537	5553	5569	5585	5600	5616	5632
50	5648	5664	5680	5696	5712	5728	5744	5760	5776	5792
51	5808	5824	5840	5858	5873	5889	5905	5921	5938	5954
52	5970	5987	6093	6019	6036	6952	6068	6085	6101	6118
53	6134	6151	6167	6184	6200	6217	6233	6250	6267	6283
54	6300	6317	6333	6350	6367	6383	6400	6417	6434	6451
55	6468	6484	6501	6518	6535	6552	6569	6586	6603	6620
56	6637	6654	6671	6688	6705	6722	6739	6757	6774	6791
57	6808	6825	6843	6860	6877	6895	6912	6929	6947	6964
58	6981	6999	7016	7034	7051	7069	7086	7104	7121	7139
59	7156	7174	7192	7209	7227	7245	7262	7280	7298	7315
60	7333	7351	7369	7387	7405	7422	7440	7458	7476	7494

For continuation to 100 feet see Table 13.

Table 12.—LEVEL CUTTINGS.

Roadway 28 feet wide, side-slopes ¼ to 1.

Depth in ft.	·0	·1	·2	·3	·4	·5	·6	·7	·8	·9
	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.
0		10·4	20·8	31·2	41·6	52·1	62·6	73·0	83·6	94·1
1	104·6	115·2	125·8	136·4	147·0	157·6	168·3	179·0	189·7	200·4
2	211·1	221·9	232·6	243·4	254·3	265·1	275·9	286·8	297·7	308·6
3	319·4	330·4	341·3	352·3	363·3	374·3	385·4	396·4	407·5	418·6
4	429·7	440·8	451·9	463·1	474·3	485·5	496·7	508·0	519·2	530·5
5	541·7	553·0	564·3	575·6	587·0	598·4	609·7	621·1	632·6	644·0
6	655·6	667·1	678·7	690·3	702·0	713·6	725·3	737·0	747·7	759·4
7	771·3	783·0	794·7	806·4	818·1	829·9	841·6	853·4	865·3	877·1
8	888·9	900·8	912·6	923·6	935·5	947·4	959·4	971·4	983·4	995·4
9	1007	1019	1032	1044	1056	1068	1080	1092	1105	1117
10	1130	1142	1154	1166	1179	1191	1203	1216	1228	1240
11	1253	1265	1278	1290	1303	1315	1328	1340	1353	1365
12	1378	1390	1403	1416	1428	1441	1454	1466	1479	1492
13	1505	1517	1530	1543	1556	1569	1582	1595	1607	1620
14	1633	1646	1659	1672	1685	1699	1712	1725	1738	1751
15	1764	1777	1790	1803	1817	1830	1843	1856	1870	1883
16	1896	1910	1923	1936	1950	1963	1977	1990	2004	2017
17	2031	2044	2058	2071	2085	2098	2112	2126	2139	2153
18	2167	2180	2194	2208	2222	2235	2249	2263	2277	2291
19	2305	2318	2332	2346	2360	2374	2388	2402	2416	2430
20	2444	2459	2473	2487	2501	2515	2529	2543	2558	2572
21	2586	2600	2615	2629	2643	2658	2672	2686	2701	2715
22	2730	2744	2759	2773	2788	2802	2817	2831	2846	2860
23	2875	2890	2904	2919	2934	2948	2963	2978	2993	3007
24	3022	3037	3052	3067	3082	3097	3111	3126	3141	3156
25	3171	3186	3201	3216	3232	3247	3262	3277	3292	3307
26	3322	3337	3353	3368	3383	3398	3414	3429	3444	3460
27	3475	3490	3506	3521	3537	3552	3568	3583	3599	3614
28	3630	3645	3661	3676	3692	3708	3723	3739	3755	3770
29	3786	3802	3818	3833	3849	3865	3881	3897	3913	3928
30	3944	3960	3976	3992	4008	4024	4040	4056	4072	4088
31	4105	4121	4137	4153	4169	4185	4202	4218	4234	4250
32	4267	4283	4299	4316	4332	4348	4365	4381	4398	4414
33	4431	4447	4464	4480	4497	4513	4530	4546	4563	4580
34	4596	4613	4630	4646	4663	4680	4697	4713	4730	4747
35	4764	4781	4797	4814	4831	4848	4865	4882	4899	4916
36	4933	4950	4967	4984	5001	5018	5036	5053	5070	5087
37	5104	5121	5138	5155	5173	5190	5207	5225	5242	5259
38	5278	5295	5313	5330	5348	5365	5383	5400	5418	5436
39	5453	5471	5488	5505	5523	5541	5559	5576	5594	5612
40	5630	5647	5665	5683	5701	5719	5737	5755	5772	5790
41	5808	5826	5844	5862	5880	5898	5916	5935	5953	5971
42	5989	6007	6025	6043	6062	6080	6098	6116	6135	6153
43	6171	6190	6208	6226	6245	6263	6282	6300	6319	6337
44	6356	6374	6393	6411	6430	6448	6467	6486	6504	6523
45	6542	6560	6579	6598	6617	6635	6654	6673	6692	6711
46	6730	6749	6767	6786	6805	6824	6843	6862	6881	6900
47	6919	6938	6958	6977	6996	7015	7034	7053	7072	7092
48	7111	7130	7150	7169	7188	7208	7227	7246	7266	7285
49	7305	7324	7343	7363	7382	7402	7422	7441	7461	7480
50	7500	7520	7539	7559	7579	7598	7618	7638	7658	7677
51	7697	7717	7737	7757	7777	7796	7816	7836	7856	7876
52	7896	7916	7936	7956	7976	7997	8017	8037	8057	8077
53	8097	8117	8138	8158	8178	8198	8219	8239	8259	8280
54	8300	8320	8341	8361	8382	8402	8423	8443	8464	8484
55	8505	8525	8546	8566	8587	8608	8628	8649	8670	8690
56	8711	8732	8753	8773	8794	8815	8836	8857	8878	8899
57	8919	8940	8961	8982	9003	9024	9045	9066	9087	9109
58	9130	9151	9172	9193	9214	9235	9257	9278	9299	9320
59	9342	9363	9384	9406	9427	9448	9470	9491	9513	9534
60	9556	9577	9599	9620	9642	9663	9685	9706	9728	9750

For continuation to 100 feet, see table 13.

TABLE 13.—LEVEL CUTTINGS.

Continuation of the foregoing Tables of Cubic Contents to 100 *feet of height or depth.*

Height or Depth in feet.	TABLE 1	TABLE 2	TABLE 3	TABLE 4	TABLE 5	TABLE 6	TABLE 7	TABLE 8	TABLE 9	TABLE 10	TABLE 11	TABLE 12
	cu yd.	cu yd.	cu yd.	cu yd.	cu yd.	cu yd.	cu yd.	cu yd.	cu yd.	cu yd.	cu. yds.	cu. yds.
61	23835	26094	17848	21294	24739	31630	20107	23553	26998	33889	7512	9771
·5	24201	26479	18108	21610	25113	32117	20386	23888	27390	34394	7602	9880
62	24570	26867	18370	21930	25489	32607	20667	24226	27785	34904	7693	9989
·5	24942	27257	18634	22251	25868	33102	20949	24566	28183	35417	7784	10098
63	25317	27650	18900	22575	26250	33600	21233	24908	28583	35933	7875	10208
·5	25694	28046	19168	22901	26635	34102	21519	25253	28986	36454	7967	10319
64	26074	28444	19437	23230	27022	34607	21807	25600	29393	36978	8059	10430
·5	26457	28846	19708	23560	27413	35117	22097	25949	29801	37506	8152	10541
65	26843	29250	19981	23894	27806	35630	22389	26300	30213	38037	8245	10653
·5	27231	29657	20256	24229	28201	36146	22682	26654	30627	38572	8339	10765
66	27622	30067	20533	24567	28600	36667	22978	27011	31044	39111	8433	10878
·5	28016	30479	20812	24907	29001	37191	23275	27369	31464	39654	8528	10991
67	28413	30894	21093	25249	29406	37719	23574	27730	31887	40200	8623	11105
·5	28812	31313	21375	25594	29813	38250	23875	28093	32312	40750	8719	11219
68	29215	31733	21659	25941	30222	38785	24178	28459	32741	41304	8815	11333
·5	29620	32157	21945	26290	30635	39324	24482	28827	33172	41861	8911	11448
69	30028	32583	22233	26642	31050	39867	24789	29197	33605	42422	9008	11564
·5	30438	33013	22523	26996	31468	40413	25097	29569	34042	42987	9106	11680
70	30852	33444	22814	27352	31889	40963	25407	29944	34481	43556	9204	11796
·5	31268	33879	23108	27710	32313	41517	25719	30321	34924	44128	9302	11913
71	31687	34317	23404	28071	32739	42074	26033	30701	35369	44704	9401	12031
·5	32108	34757	23701	28434	33168	42635	26349	31083	35816	45283	9500	12148
72	32533	35200	24000	28800	33600	43200	26667	31467	36267	45867	9600	12267
·5	32960	35646	24310	29168	34035	43769	26986	31853	36720	46451	9700	12385
73	33390	36094	24604	29538	34472	44341	27307	32241	37176	47044	9801	12505
·5	33823	36546	24907	29910	34913	44917	27631	32632	37635	47639	9902	12624
74	34259	37000	25214	30285	35356	45496	27956	33026	38096	48237	10004	12744
·5	34697	37457	25522	30662	35801	46080	28282	33421	38561	48839	10106	12865
75	35139	37917	25832	31042	36250	46667	28611	33819	39028	49444	10208	12986
·5	35582	38379	26144	31423	36701	47257	28942	34219	39498	50054	10311	13108
76	36029	38844	26458	31807	37156	47852	29174	34622	39970	50667	10415	13230
·5	36479	39313	26774	32194	37613	48450	29608	35027	40446	51283	10519	13352
77	36931	39783	27092	32582	38072	49052	29944	35431	40924	51904	10623	13475
·5	37386	40257	27411	32973	38535	49657	30282	35843	41405	52528	10728	13598
78	37844	40733	27733	33367	39000	50267	30622	36256	41889	53156	10833	13722
·5	38305	41213	28056	33762	39468	50880	30964	36669	42375	53787	10939	13846
79	38768	41694	28381	34160	39939	51496	31307	37086	42865	54422	11045	13971
·5	39235	42179	28708	34560	40413	52117	31653	37504	43357	55061	11152	14096
80	39701	42667	29037	34963	40889	52741	32000	37926	43852	55704	11259	14222
81	40650	43650	29700	35775	41850	54000	32700	38775	44850	57000	11475	14475
82	41607	44644	30370	36596	42822	55274	33407	39633	45859	58311	11693	14730
83	42576	45650	31048	37427	43806	56563	34122	40501	46880	59637	11912	14986
84	43555	46667	31733	38267	44800	57867	34844	41378	47911	60978	12133	15244
85	44546	47691	32426	39116	45806	59185	35574	42261	48954	62333	12357	15505
86	45548	48733	33126	39971	46822	60519	36311	43159	50008	63704	12582	15767
87	46561	49783	33833	40842	47850	61867	37056	44061	51072	65089	12808	16031
88	47585	50844	34548	41718	48889	63230	37807	44978	52148	66489	13037	16296
89	48620	51917	35270	42605	49939	64607	38567	45901	53235	67904	13268	16564
90	49667	53000	36000	43500	51000	66000	39333	46833	54333	69333	13500	16833
91	50721	54094	36737	44405	52072	67407	40107	47775	55413	70778	13734	17105
92	51793	55200	37481	45319	53156	68830	40889	48726	56563	72237	13970	17378
93	52872	56317	38233	46242	54250	70267	41678	49686	57694	73711	14208	17653
94	53963	57444	38993	47174	55356	71719	42474	50655	58837	75200	14448	17930
95	55065	58583	39759	48116	56472	73185	43278	51634	59990	76704	14690	18208
96	56178	59733	40533	49067	57600	74667	44089	52622	61155	78222	14933	18489
97	57302	60894	41315	50027	58739	76163	44907	53619	62331	79756	15179	18771
98	58437	62067	42101	50996	59889	77674	45733	54626	63518	81304	15426	19056
99	59583	63250	42900	51975	61050	79200	46567	55642	64716	82867	15675	19342
100	60741	64444	43704	52963	62222	80741	47407	56667	65926	84444	15926	19630

TABLE 14.

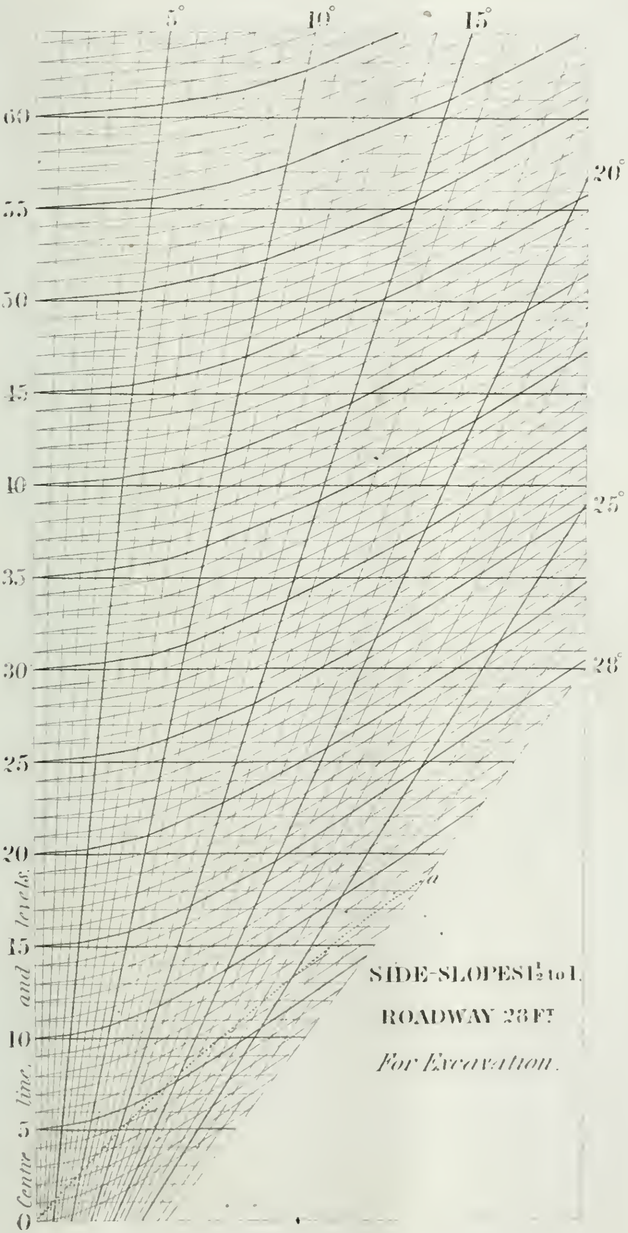
Of cubic yards in a 100 foot station, to be added to, or subtracted from, the quantities in the preceding thirteen tables, in case the excavations or embankments should be increased or diminished 2 feet in width.

The most rapid method of performing this operation would be to add together the average heights, or depths, of the equivalent level cuttings or fillings of several consecutive 100 foot stations, and divide their sum by their number, for an average one of them all. The number of cubic yards corresponding to this average height, or depth, when multiplied by the number of stations, will give the content of the entire length.

It would, however, be better for the assistant, in cases where the width of roadway differs from those in the preceding Tables, to construct at once a new table.

Cubic Yards in a length of 100 *feet; breadth* 2 *feet; and of different depths.*

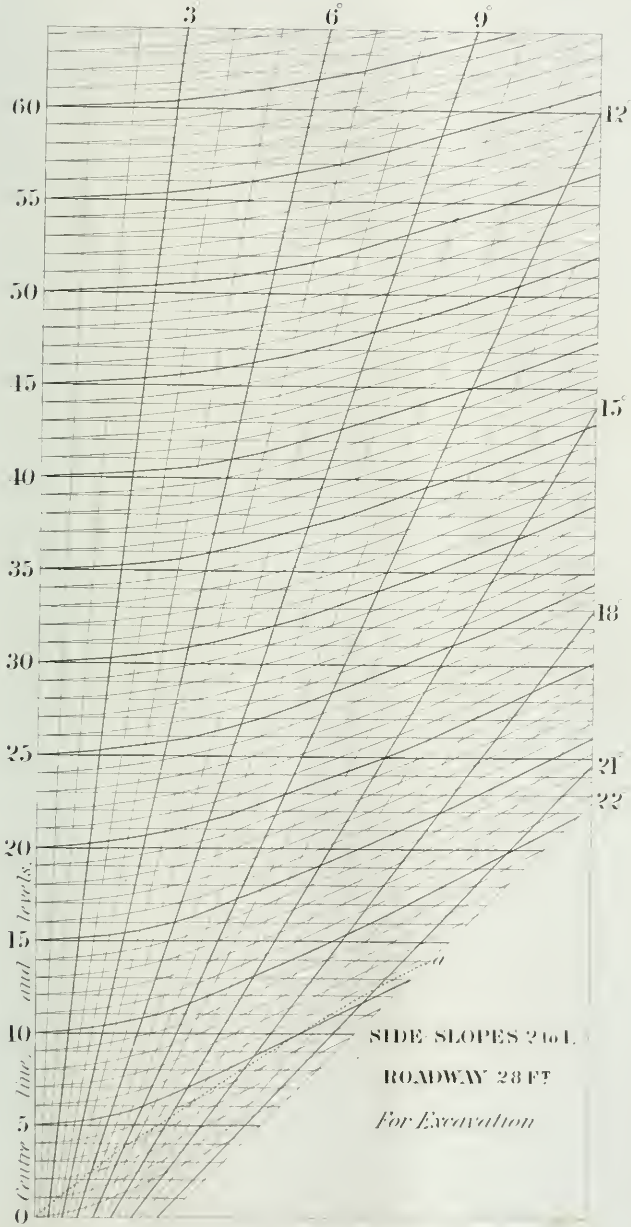
Height or Depth in feet.	Cubic Yards.	Height or Depth in feet.	Cubic Yards.	Height or Depth in feet.	Cubic Yards.	Height or Depth in feet.	Cubic Yards.	Height or Depth in feet.	Cubic Yards.
·5	3·70	·5	152	·5	300	·5	448	·5	596
1	7·41	21	156	41	304	61	452	81	600
·5	11·1	·5	159	·5	307	·5	456	·5	604
2	14·8	22	163	42	311	62	459	82	607
·5	18·5	·5	167	·5	315	·5	463	·5	611
3	22·2	23	170	43	319	63	467	83	615
·5	25·9	·5	174	·5	322	·5	470	·5	619
4	29·6	24	178	44	326	64	474	84	622
·5	33·3	·5	181	·5	330	·5	478	·5	626
5	37·0	25	185	45	333	65	481	85	630
·5	40·7	·5	189	·5	337	·5	485	·5	633
6	44·4	26	193	46	341	66	489	86	637
·5	48·1	·5	196	·5	344	·5	493	·5	641
7	51·9	27	200	47	348	67	496	87	644
·5	55·6	·5	204	·5	352	·5	500	·5	648
8	59·3	28	207	48	356	68	504	88	652
·5	63·0	·5	211	·5	359	·5	507	·5	656
9	66·7	29	215	49	363	69	511	89	659
·5	70·4	·5	219	·5	367	.5	515	·5	663
10	74·1	30	222	50	370	70	519	90	667
·5	77·8	·5	226	·5	374	·5	522	·5	670
11	81·5	31	230	51	378	71	526	91	674
·5	85·2	·5	233	·5	381	·5	530	·5	678
12	88·9	32	237	52	385	72	533	92	681
·5	92·6	·5	241	·5	389	·5	537	·5	685
13	96·3	33	244	53	393	73	541	93	689
·5	100	·5	248	·5	396	·5	544	·5	693
14	104	34	252	54	400	74	548	94	696
·5	107	·5	256	·5	404	·5	552	·5	700
15	111	35	259	55	407	75	556	95	704
·5	115	·5	263	·5	411	·5	559	·5	707
16	119	36	267	56	415	76	563	96	711
·5	122	·5	270	·5	419	·5	567	·5	715
17	126	37	274	57	422	77	570	97	719
·5	130	·5	278	·5	426	·5	574	·5	722
18	133	38	281	58	430	78	578	98	726
·5	137	·5	285	·5	433	·5	581	·5	730
19	141	39	289	59	437	79	585	99	733
·5	144	·5	293	·5	441	·5	589	·5	737
20	148	40	296	60	444	80	593	100	741



SIDE-SLOPES 1½ to 1.

ROADWAY 28 FT.

For Excavation.


3°
6°
9°
12°
15°
18°
21°
22°
60
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Centre line, and levels.
a
SIDE SLOPES 2 to 1.
ROADWAY 28 FT
For Excavation

TABLE 15.—CUBIC YARDS IN 100 FEET LENGTH.

This Table shows the number of cubic yards of Excavation, or Embankment, corresponding to different areas of cross section, and to a length of 100 feet. The areas are expressed in *square feet.*

This Table may be extended, by mentally changing the place of the decimal point; thus, the cubic yards corresponding to area of 1100 square feet will be 10 times that of 110 square feet, or 4074; those corresponding to an area of 8955 square feet will be 10 times that of 895·5 square feet, or 33167. If the number is not exactly divisible by 10, we may still take out the corresponding cubic yards with sufficient accuracy for practice, by using the nearest tabular number; thus, if we take 33167 for the cubic yards corresponding to an area of 8953 square feet, the error will be but about 8 cubic yards in 33000. A mean can, however, always be estimated in an instant by the eye, which will reduce the error to still less; thus it is seen at a glance, that 33157 is, in this instance, nearer than 33167.

Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.
1	3·70	45	166·7	89	329·6	·5	431·5	·5	513·0	·5	594·4
2	7·41	46	170·4	90	333·3	117	433·3	139	514·8	161	596·3
3	11·1	47	174·1	91	337·0	·5	435·2	·5	516·7	·5	598·2
4	14·8	48	177·8	92	340·7	118	437·0	140	518·5	162	600·0
5	18·5	49	181·5	93	344·4	·5	438·9	·5	520·4	·5	601·9
6	22·2	50	185·2	94	348·2	119	440·7	141	522·2	163	603·7
7	25·9	51	188·9	95	351·9	·5	442·6	·5	524·1	·5	605·6
8	29·6	52	192·6	96	355·6	120	444·4	142	525·9	164	607·4
9	33·3	53	195·3	97	359·3	·5	446·3	·5	527·8	·5	609·3
10	37·0	54	200·0	98	363·0	121	448·2	143	529·6	165	611·1
11	40·7	55	203·7	99	366·7	·5	450·0	·5	531·5	·5	613·0
12	44·4	56	207·4	100	370·4	122	451·9	144	533·3	166	614·8
13	48·1	57	211·1	·5	372·2	·5	453·7	·5	535·2	·5	616·7
14	51·9	58	214·8	101	374·1	123	455·6	145	537·0	167	618·5
15	55·6	59	218·5	·5	375·9	·5	457·4	·5	538·9	·5	620·4
16	59·3	60	222·2	102	377·8	124	459·3	146	540·7	168	622·2
17	63·0	61	225·9	·5	379·6	·5	461·1	·5	542·6	·5	624·1
18	66·7	62	229·6	103	381·5	125	463·0	147	544·4	169	625·9
19	70·4	63	233·3	·5	383·3	·5	464·8	·5	546·3	·5	627·8
20	74·1	64	237·0	104	385·2	126	466·7	148	548·2	170	629·6
21	77·8	65	240·7	·5	387·0	·5	468·5	·5	550·0	·5	631·5
22	81·5	66	244·4	105	388·9	127	470·4	149	551·9	171	633·3
23	85·2	67	248·2	·5	390·7	·5	472·2	·5	553·7	·5	635·2
24	88·9	68	251·9	106	392·6	128	474·1	150	555·6	172	637·0
25	92·6	69	255·6	·5	394·4	·5	475·9	·5	557·4	·5	638·9
26	96·3	70	259·3	107	396·3	129	477·8	151	559·3	173	640·7
27	100·0	71	263·0	·5	398·2	·5	479·6	·5	561·1	·5	642·6
28	103·7	72	266·7	108	400·0	130	481·5	152	563·0	174	644·4
29	107·4	73	270·4	·5	401·9	·5	483·3	·5	564·8	·5	646·3
30	111·1	74	274·1	109	403·7	131	485·2	153	566·7	175	648·2
31	114·8	75	277·8	·5	405·6	·5	487·0	·5	568·5	·5	650·0
32	118·5	76	281·5	110	407·4	132	488·9	154	570·4	176	651·9
33	122·2	77	285·2	·5	409·3	·5	490·7	·5	572·2	·5	653·7
34	125·9	78	288·9	111	411·1	133	492·6	155	574·1	177	655·6
35	129·6	79	292·6	·5	413·0	·5	491.4	·5	575·9	·5	657·4
36	133·3	80	296·3	112	414·8	134	496·3	156	577·8	178	659·3
37	137·0	81	300·0	·5	416·7	·5	498·2	·5	579·6	·5	661·1
38	140·7	82	303·7	113	418·5	135	500·0	157	581·5	179	663·0
39	144·4	83	307·4	·5	420·4	·5	501·9	·5	583·3	·5	664·8
40	148·2	84	311·1	114	422·2	136	503·7	158	585·2	180	666·7
41	151·9	85	314·8	·5	424·1	·5	505·6	·5	587·0	·5	668·5
42	155·6	86	318.5	115	425·9	137	507·4	159	588·9	181	670·4
43	159·3	87	322·2	·5	427·8	·5	509·3	·5	590·7	·5	672·2
44	163·0	88	325·9	116	429·6	138	511·1	160	592·6	182	674·1

TABLE 15.—CUBIC YARDS IN 100 FEET LENGTH.

Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards	Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.
·5	675·9	·5	783·3	·5	890·7	·5	998·2	·5	1105·6	·5	1213·0
183	677·8	212	785·2	241	892·6	270	1000·0	299	1107·4	328	1214·8
·5	679·6	·5	787·0	.5	894·4	·5	1001·9	·5	1109·3	·5	1216·7
184	681·5	213	788·9	242	896·3	271	1003·7	300	1111·1	329	1218·5
·5	683·3	·5	790·7	·5	898·2	·5	1005·6	·5	1113·0	·5	1220·4
185	685·2	214	792·6	243	900·0	272	1007·4	301	1114·8	330	1222·2
·5	687·0	·5	794·4	·5	901·9	·5	1009·3	·5	1116·7	·5	1224·1
186	688·9	215	796·3	244	903·7	273	1011·1	302	1118·5	331	1225·9
·5	690·7	·5	798·2	·5	905·6	·5	1013·0	·5	1120·4	·5	1227·8
187	692·6	216	800·0	245	907·4	274	1014·8	303	1122·2	332	1229·6
·5	694·4	·5	801·9	·5	909·3	.5	1016·7	·5	1124·1	·5	1231·5
188	696·3	217	803·7	246	911·1	275	1018·5	304	1125·9	333	1233·3
·5	698·2	·5	805·6	·5	913·0	·5	1020·4	·5	1127·8	·5	1235·2
189	700·0	218	807·4	247	914·8	276	1022·2	305	1129·6	334	1237·0
·5	701·9	·5	809·3	·5	916·7	·5	1024·1	·5	1131·5	·5	1238·9
190	703·7	219	811·1	248	918·5	277	1025·9	396	1133·3	335	1240·7
·5	705.6	·5	813·0	·5	920·4	·5	1027·8	·5	1135·2	·5	1242·6
191	707·4	220	814·8	249	922·2	278	1029·6	307	1137·0	336	1244·4
·5	709·3	·5	816·7	·5	924·1	·5	1031·5	·5	1138·9	·5	1246·3
192	711·1	221	818·5	250	925·9	279	1033·3	308	1140·7	337	1248·2
·5	713·0	·5	820·4	·5	927·8	·5	1035·2	·5	1142·6	·5	1250·0
193	714·8	222	822·2	251	929·6	280	1037·0	309	1144·4	338	1251·9
·5	716·7	·5	824·1	·5	931·5	·5	1038·9	·5	1146·3	·5	1253·7
194	718·5	223	825·9	252	933·3	281	1040·7	310	1148·2	339	1255·6
·5	720·4	·5	827·8	·5	935·2	·5	1042·6	·5	1150·0	·5	1257·4
195	722·2	224	829·6	253	937·0	282	1044·4	311	1151·9	340	1259·3
·5	724·1	·5	831·5	·5	938·9	·5	1046·3	·5	1153·7	·5	1261·1
196	725·9	225	833·3	254	940·7	283	1048·2	312	1155·6	341	1263·0
·5	727·8	·5	835·2	·5	942·6	·5	1050·0	·5	1157·4	·5	1264·8
197	729·6	226	837·0	255	944·4	284	1051·9	313	1159.3	342	1266·7
·5	731·5	·5	838·9	·5	946·3	·5	1053·7	·5	1161·1	·5	1268·5
198	733·3	227	840·7	256	948·2	285	1055·6	314	1163·0	343	1270·4
·5	735·2	·5	842·6	·5	950·0	·5	1057·4	·5	1164·8	·5	1272·2
199	737·0	228	844·4	257	951·9	286	1059·3	315	1166·7	344	1274·1
·5	738·9	·5	846·3	·5	953·7	·5	1061·1	·5	1168·5	·5	1275·9
200	740·7	229	848·2	258	955·6	287	1063·0	316	1170·4	345	1277·8
·5	742·6	·5	850·0	·5	957·4	·5	1064·8	·5	1172·2	·5	1279·6
201	744·4	230	851·9	259	959·3	288	1066·7	317	1174·1	346	1281·5
·5	746·3	·5	853·7	·5	961·1	·5	1068·5	·5	1175·9	·5	1283·3
202	748·2	231	855·6	260	963·0	289	1070·4	318	1177·8	347	1285·2
·5	750·0	·5	857·4	·5	964·8	·5	1072·2	·5	1179·6	·5	1287·0
203	751·9	232	859·3	261	966·7	290	1074·1	319	1181·5	348	1288·9
·5	753·7	·5	861·1	·5	968·5	·5	1075·9	·5	1183·3	·5	1290·7
204	755·6	233	863·0	262	970·4	291	1077·8	320	1185·2	349	1292·6
·5	757·4	·5	864·8	·5	972·2	·5	1079·6	·5	1187·0	·5	1294·4
205	759·3	234	866·7	263	974·1	292	1081·5	321	1188·9	350	1296·3
·5	761·1	·5	868·5	·5	975·9	·5	1083·3	·5	1190·7	·5	1298·2
206	763·0	235	870·4	264	977·8	293	1085·2	322	1192·6	351	1300·0
·5	764·8	·5	872·2	·5	979·6	·5	1087·0	·5	1194·4	.5	1301·9
207	766·7	236	874·1	265	981·5	294	1088·9	323	1196·3	352	1303·7
·5	768·5	·5	875·9	·5	983·3	·5	1090·7	·5	1198·2	·5	1305·6
208	770·4	237	877·8	266	985·2	295	1092·6	324	1200·0	353	1307·4
·5	772·2	·5	879·6	·5	987·0	·5	1091·4	·5	1201·9	·5	1309·3
209	774·1	238	881·5	267	988·9	296	1096·3	325	1203·7	354	1311·1
·5	775·9	·5	883·3	·5	990·7	·5	1098·2	·5	1205·6	·5	1313·0
210	777·8	239	885·2	268	992·6	297	1100·0	326	1207·4	355	1314·8
.5	779·6	·5	887·0	·5	994·4	·5	1101·9	·5	1209·3	·5	1316·7
211	781·5	240	888·9	269	996·3	298	1103·7	327	1211·1	356	1318·5

TABLE 15.—CUBIC YARDS IN 100 FEET LENGTH.

Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.
·5	1320·4	·5	1427·8	·5	1535·2	·5	1642·6	·5	1750.0	·5	1857.4
357	1322·2	386	1429·6	415	1537·0	444	1644·4	473	1751·9	502	1859·3
·5	1324·1	·5	1431·5	·5	1538·9	·5	1646·3	·5	1753·7	·5	1861·1
358	1325·9	387	1433·3	416	1540·7	445	1648·2	474	1755·6	503	1863·0
·5	1327·8	·5	1435·2	·5	1542·6	·5	1650·0	·5	1757·4	·5	1864·8
359	1329·6	388	1437·0	417	1544.4	446	1651·9	475	1759·3	504	1866·7
·5	1331·5	·5	1438·9	·5	1546·3	·5	1653·7	.5	1761·1	·5	1868·5
360	1333·3	389	1440·7	418	1548·2	447	1655·6	476	1763·0	505	1870·4
·5	1335·2	·5	1442·6	·5	1550·0	·5	1657·4	·5	1764·8	·5	1872·2
361	1337·0	390	1444·4	419	1551·9	448	1659·3	477	1766·7	506	1874·1
·5	1338·9	·5	1446·3	·5	1553·7	·5	1661·1	·5	1768·5	·5	1875·9
362	1340·7	391	1448·2	420	1555·6	449	1663·0	478	1770·4	507	1877·8
·5	1342·6	·5	1450·0	·5	1557·4	·5	1664·8	·5	1772·2	·5	1879·6
363	1344·4	392	1451·9	421	1559·3	450	1666·7	479	1774·1	508	1881·5
·5	1346·3	·5	1453·7	·5	1561·1	·5	1668·5	·5	1775·9	·5	1883·3
364	1348·2	393	1455·6	422	1563·0	451	1670·4	480	1777·8	509	1885·2
·5	1350·0	·5	1457·4	·5	1564·8	·5	1672·2	·5	1779·6	·5	1887·0
365	1351·9	394	1459·3	423	1566·7	452	1674·1	481	1781·5	510	1888·9
·5	1353·7	·5	1461·1	·5	1568·5	·5	1675·9	·5	1783·3	·5	1890·7
366	1355·6	395	1463·0	424	1570·4	453	1677·8	482	1785·2	511	1892·6
·5	1357·4	·5	1464·8	·5	1572·2	·5	1679·6	·5	1787·0	·5	1894·4
367	1359·3	396	1466·7	425	1574·1	454	1681·5	483	1788·9	512	1896·3
·5	1361·1	.5	1468·5	·5	1575·9	.5	1683·3	·5	1790·7	·5	1898·2
368	1363·0	397	1470·4	426	1577·8	455	1685·2	484	1792·6	513	1900·0
·5	1364·8	·5	1472·2	·5	1579·6	·5	1687·0	·5	1794·4	·5	1901·9
369	1366·7	398	1474·1	427	1581·5	456	1688·9	485	1796·3	514	1903·7
·5	1368·5	·5	1475·9	·5	1583·3	·5	1690·7	·5	1798·2	·5	1905·6
370	1370·4	399	1477·8	428	1585·2	457	1692·6	486	1800·0	515	1907·4
·5	1372·2	·5	1479·6	·5	1587·0	·5	1694·4	.5	1801·9	·5	1909·3
371	1374·1	400	1481·5	429	1588·9	458	1696·3	487	1803·7	516	1911·1
·5	1375·9	·5	1483·3	·5	1590·7	·5	1698·2	·5	1805·6	·5	1913·0
372	1377·8	401	1485·2	430	1592·6	459	1700·0	488	1807·4	517	1914·8
·5	1379·6	·5	1487·0	·5	1594·4	·5	1701·9	·5	1809·3	·5	1916·7
373	1381·5	402	1488·9	431	1596·3	460	1703·7	489	1811·1	518	1918·5
·5	1383·3	·5	1490·7	·5	1598·2	·5	1705·6	·5	1813·0	·5	1920·4
374	1385·2	403	1492·6	432	1600·0	461	1707·4	490	1814·8	519	1922·2
·5	1387·0	·5	1494·4	·5	1601·9	·5	1709·3	·5	1816·7	·5	1924·1
375	1388·9	404	1496·3	433	1603·7	462	1711·1	491	1818·5	520	1925·9
·5	1390·7	·5	1498·2	·5	1605·6	·5	1713·0	·5	1820·4	·5	1927·8
376	1392·6	405	1500·0	434	1607·4	463	1714·8	492	1822·2	521	1929·6
·5	1394·4	·5	1501·9	·5	1609·3	·5	1716·7	·5	1824·1	·5	1931·5
377	1396·3	406	1503·7	435	1611.1	464	1718·5	493	1825·9	522	1933·3
·5	1398·2	·5	1505·6	·5	1613·0	·5	1720·4	·5	1827·8	·5	1935·2
378	1400·0	407	1507·4	436	1614·8	465	1722·2	494	1829·6	523	1937·0
·5	1401·9	·5	1509·3	·5	1616·7	·5	1724·1	·5	1831·5	·5	1938·9
379	1403·7	408	1511·1	437	1618·5	466	1725·9	495	1833·3	524	1940·7
·5	1405·6	·5	1513·0	·5	1620·4	·5	1727·8	·5	1835·2	·5	1942·6
380	1407·4	409	1514·8	438	1622·2	467	1729·6	496	1837 0	525	1944·4
·5	1409·3	·5	1516·7	·5	1624·1	·5	1731·5	·5	1838·9	·5	1946·3
381	1411·1	410	1518·5	439	1625·9	468	1733·3	497	1840·7	526	1948·2
·5	1413·0	·5	1520·4	·5	1627·8	·5	1735·2	·5	1842·6	·5	1950·0
382	1414·8	411	1522·2	440	1629·6	469	1737·0	498	1844·4	527	1951·9
·5	1416·7	·5	1524·1	·5	1631·5	·5	1738·9	·5	1846·3	·5	1953·7
383	1418·5	412	1525·9	441	1633·3	470	1740·7	499	1848·2	528	1955·6
·5	1420·4	·5	1527·8	·5	1635·2	·5	1742·6	·5	1850·0	·5	1957·4
384	1422·2	413	1529·6	442	1637·0	471	1744·4	500	1851·9	529	1959·3
·5	1424·1	·5	1531·5	·5	1638·9	·5	1746·3	·5	1853·7	·5	1961·1
385	1425·9	414	1533·3	443	1640·7	472	1748·2	501	1855·6	530	1963·0

TABLE 15.—CUBIC YARDS IN 100 FEET LENGTH.

Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.
·5	1964·8	·5	2072·2	·5	2179·6	·5	2287·0	·5	2394·4	·5	2501·9
531	1966·7	560	2074·1	589	2181·5	618	2288·9	647	2396·3	676	2503.7
·5	1968·5	·5	2075·9	·5	2183·3	·5	2290·7	·5	2398·2	·5	2505·6
532	1970·4	561	2077·8	590	2185·2	619	2292·6	648	2400·0	677	2507·4
·5	1972·2	·5	2079·6	·5	2187·0	·5	2294·4	·5	2401·9	·5	2509·3
533	1974·1	562	2081·5	591	2188·9	620	2296·3	649	2403·7	678	2511·1
·5	1975·9	·5	2083·3	·5	2190·7	·5	2298·2	·5	2405·6	·5	2513·0
534	1977·8	563	2085·2	592	2192·6	621	2300·0	650	2407·4	679	2514·8
·5	1979·6	·5	2087·0	·5	2194·4	·5	2301·9	·5	2409·7	·5	2516·7
535	1981·5	564	2088·9	593	2196·3	622	2303·7	651	2411·1	680	2518·5
·5	1983·3	·5	2090·7	·5	2198·2	·5	2305·6	·5	2413·0	·5	2520·4
536	1985·2	565	2092·6	594	2200·0	623	2307·4	652	2414·8	681	2522·2
·5	1987·0	·5	2094·4	·5	2201·9	·5	2309·3	·5	2416·7	·5	2524·1
537	1988·9	566	2096·3	595	2203·7	624	2311·1	653	2418·5	682	2525·9
·5	1990·7	·5	2098·2	·5	2205·6	·5	2313·0	·5	2420·4	·5	2527·8
538	1992·6	567	2100·0	596	2207·4	625	2314·8	654	2422·2	683	2529·6
·5	1994·4	·5	2101·9	·5	2209·3	·5	2316·7	·5	2424·1	·5	2531·5
539	1996·3	568	2103·7	597	2211·1	626	2318·5	655	2425·9	684	2533·3
·5	1998·2	·5	2105·6	·5	2213·0	·5	2320·4	·5	2427.8	·5	2535·2
540	2000·0	569	2107·4	598	2214·8	627	2322·2	656	2429·6	685	2537·0
·5	2001·9	·5	2109·3	·5	2216·7	·5	2324·1	·5	2431·5	·5	2538·9
541	2003·7	570	2111·1	599	2218·5	628	2325·9	657	2433·3	686	2540·7
·5	2005·6	·5	2113·0	·5	2220·4	·5	2327·8	·5	2435·2	·5	2542·6
542	2007·4	571	2114·8	600	2222·2	629	2329·6	658	2437·0	687	2544·4
·5	2009·3	·5	2116·7	·5	2224·1	·5	2331·5	·5	2438·9	·5	2546·3
543	2011·1	572	2118·5	601	2225·9	630	2333·3	659	2440·7	688	2548·2
·5	2013·0	·5	2120·4	·5	2227·8	·5	2335·2	·5	2442·6	·5	2550·0
544	2014·8	573	2122·2	602	2229·6	631	2337·0	660	2444·4	689	2551·9
·5	2016·7	·5	2124·1	·5	2231·5	·5	2338·9	·5	2446·3	·5	2553·7
545	2018·5	574	2125·9	603	2233·3	632	2340·7	661	2448·2	690	2555·6
·5	2020·4	·5	2127·8	·5	2235·2	·5	2342·6	·5	2450·0	·5	2557·4
546	2022·2	575	2129·6	604	2237·0	633	2344·4	662	2451·9	691	2559·3
·5	2024.1	·5	2131·5	·5	2238·9	·5	2346·3	·5	2453·7	·5	2561·1
547	2025·9	576	2133·3	605	2240·7	634	2348·2	663	2455·6	692	2563·0
·5	2027·7	·5	2135·2	·5	2242·6	·5	2350·0	·5	2457·4	·5	2564·8
548	2029·6	577	2137·0	606	2244·4	635	2351·9	664	2459·3	693	2566·7
·5	2031·5	·5	2138·9	·5	2246·3	·5	2353·7	·5	2461·1	·5	2568·5
549	2033·3	578	2140·7	607	2248·2	636	2355·6	665	2463·0	694	2570·4
·5	2035·2	·5	2142·6	·5	2250·0	·5	2357·4	·5	2464·8	·5	2572·2
550	2037·0	579	2144·4	608	2251·9	637	2359·3	666	2466·7	695	2574·1
·5	2039·9	·5	2146·3	·5	2253·7	·5	2361·1	·5	2468·5	·5	2575·9
551	2040·7	580	2148·2	609	2255·6	638	2363·0	667	2470·4	696	2577·8
·5	2042·6	·5	2150·0	·5	2257·4	·5	2364·8	·5	2472·2	·5	2579·6
552	2044·4	581	2151·9	610	2259·3	639	2366·7	668	2474·1	697	2581·5
·5	2046·3	·5	2153·7	·5	2261·1	·5	2368·5	·5	2475·9	·5	2583·3
553	2048·2	582	2155·6	611	2263·0	640	2370·4	669	2477·8	698	2585·2
·5	2050·0	·5	2157·4	·5	2264·8	·5	2372·2	·5	2479·6	·5	2587.0
554	2051·9	583	2159·3	612	2266·7	641	2374·1	670	2481·5	699	2588·9
·5	2053·7	·5	2161·1	·5	2268·5	·5	2375·9	·5	2483·3	·5	2590·7
555	2055·6	584	2163·0	613	2270·4	642	2377·8	671	2485·2	700	2592·6
·5	2057·4	·5	2164·8	·5	2272·2	·5	2379·6	·5	2487·0	·5	2594·4
556	2059·3	585	2166·7	614	2274·1	643	2381·2	672	2488·9	701	2596·3
·5	2061·1	·5	2168·5	·5	2275·9	·5	2383·3	·5	2490·7	·5	2598·2
557	2063·0	586	2170·4	615	2277·8	644	2385.2	673	2492·6	702	2600·0
·5	2064·8	·5	2172·2	·5	2279·6	·5	2387·0	·5	2494·4	·5	2601·9
558	2066·7	587	2174·1	616	2281·5	645	2388·9	674	2496·3	703	2603·7
·5	2068·5	·5	2175·9	·5	2283·3	·5	2390·7	·5	2498·2	·5	2605·6
559	2070·4	588	2177·8	617	2285·2	646	2392·6	675	2500·0	704	2607·4

TABLE 15.—CUBIC YARDS IN 100 FEET LENGTH.

Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.
·5	2609·3	.5	2716·7	·5	2824·1	·5	2931·5	·5	3038·9	·5	3146·3
705	2611·1	734	2718·5	763	2825·9	792	2933·3	821	3040·7	850	3148·2
·5	2613·0	·5	2720·4	·5	2827·8	·5	2935·2	·5	3042·6	·5	3150·0
706	2614·8	735	2722·2	764	2829·6	793	2937·0	822	3044·4	851	3151·9
·5	2616·7	·5	2724·1	·5	2831·5	·5	2938·9	.5	3046·3	·5	3153·7
707	2618·5	736	2725·9	765	2833·3	794	2940·4	823	3048·2	852	3155·6
·5	2620·4	·5	2727·8	·5	2835·2	·5	2942·6	·5	3050·0	·5	3157·4
708	2622·2	737	2729·6	766	2837·0	795	2944·4	824	3051·9	853	3159·3
·5	2624·1	·5	2731·5	·5	2838·9	·5	2946·3	·5	3053·7	·5	3161·1
709	2625·9	738	2733·3	767	2840·7	796	2948·2	825	3055·6	854	3163·0
·5	2627.8	·5	2735·2	·5	2842·6	·5	2950·0	·5	3057·4	·5	3164·8
710	2629·6	739	2737·0	768	2844·4	797	2951·9	826	3059·3	855	3166·7
·5	2631·5	·5	2738·9	·5	2846·3	·5	2953·7	·5	3061·1	·5	3168·5
711	2633·3	740	2740·7	769	2848·2	798	2955·6	827	3063·0	856	3170·4
·5	2635·2	·5	2742·6	·5	2850·0	·5	2957·4	·5	3064·8	·5	3172·2
712	2637·0	741	2744·4	770	2851·9	799	2959·3	828	3066·7	857	3174·1
·5	2638·9	·5	2746·3	·5	2853·7	·5	2961·1	·5	3068.5	·5	3175·9
713	2640·7	742	2748·2	771	2855·6	800	2963·0	829	3070·4	858	3177·8
·5	2642·6	·5	2750·0	·5	2857·4	·5	2964·8	·5	3072·2	·5	3179·6
714	2644·4	743	2751·9	772	2859·3	801	2966.7	830	3074.1	859	3181·5
·5	2646·3	·5	2753·7	·5	2861·1	·5	2968·5	·5	3075·9	·5	3183·3
715	2648·2	744	2755·6	773	2863·0	802	2970·4	831	3077·8	860	3185·2
·5	2650·0	·5	2757·4	·5	2864·8	·5	2972,2	·5	3079·6	·5	3187·0
716	2651·9	745	2759·3	774	2866·7	803	2974·1	832	3081·5	861	3188·9
·5	2653·7	·5	2761·1	·5	2868·5	·5	2975·9	·5	3083·3	·5	3190·7
717	2655·6	746	2763·0	775	2870·4	804	2977·8	833	3085·2	862	3192·6
·5	2657·4	·5	2764·8	·5	2872·2	·5	2979·6	·5	3087·0	·5	3194·4
718	2659·3	747	2766·7	776	2874·1	805	2981·5	834	3088·9	863	3196·3
·5	2661·1	·5	2768·5	·5	2875·9	·5	2983·3	·5	3090·7	·5	3198·2
719	2663.0	748	2770·4	777	2877·8	806	2985·2	835	3092·6	864	3200·0
·5	2664·8	·5	2772·2	·5	2879·6	·5	2987·0	·5	3094·4	·5	3201·9
720	2666·7	749	2774·1	778	2881·5	807	2988·9	836	3096·3	865	3203·7
·5	2668·5	·5	2775·9	·5	2883·3	·5	2990·7	·5	3098·2	·5	3205·6
721	2670.4	750	2777·8	779	2885·2	808	2992·6	837	3100·0	866	3207·4
·5	2672·2	·5	2779·6	·5	2887·0	·5	2994·4	·5	3101·9	·5	3209·3
722	2674·1	751	2781·5	780	2888·9	809	2996·3	838	3103·7	867	3211·1
·5	2675·9	·5	2783·3	·5	2890·7	·5	2998·2	·5	3105·6	·5	3213·0
723	2677·8	752	2785·2	781	2892·6	810	3000·0	839	3107·4	868	3214·8
·5	2679·6	·5	2787·0	·5	2894·4	·5	3001·9	·5	3109·3	·5	3216·7
724	2681·5	753	2788·9	782	2896·3	811	3003·7	840	3111·1	869	3218·5
·5	2683·3	·5	2790·7	·5	2898·2	·5	3005·6	·5	3113·0	·5	3220·4
725	2685·2	754	2792.6	783	2900·0	812	3007·4	841	3114·8	870	3222·2
·5	2687·0	·5	2794·4	·5	2901·9	·5	3009·3	·5	3116·7	·5	3224·1
726	2688·2	755	2796·3	784	2903·7	813	3011·1	842	3118·5	871	3225·9
·5	2690·7	·5	2798·2	·5	2905·6	·5	3013·0	·5	3120·4	·5	3227·8
727	2692·6	756	2800·0	785	2907·4	814	3014·8	843	3122·2	872	3229·6
·5	2694·4	·5	2801·9	·5	2909·3	·5	3016·7	·5	3124·1	·5	3231·5
728	2696·3	757	2803·7	786	2911·1	815	3018·5	844	3125·9	873	3233·3
·5	2698·2	·5	2805·6	·5	2913·0	·5	3020·4	·5	3127·8	·5	3235·2
729	2700·0	758	2807·4	787	2914·8	816	3022·2	845	3129·6	874	3237·0
·5	2701·5	5·	2809·3	·5	2916·7	·5	3024·1	·5	3131·5	·5	3238·9
730	2703·7	759	2811·1	788	2918·5	817	3025·9	846	3133·3	875	3240·7
·5	2705·6	5·	2813·0	·5	2920·4	·5	3027·8	·5	3135·2	·5	3242·6
731	2707·4	760	2814·8	789	2922·2	818	3029·6	847	3137·0	876	3244·4
·5	2709·3	·5	2816·7	·5	2924·1	·5	3031·5	·5	3138·9	·5	3246·3
732	2711·1	761	2818·5	790	2925·9	819	3033·3	848	3140·7	877	3248·2
·5	2713·0	·5	2820·4	·5	2927·8	·5	3035·2	·5	3142·6	·5	3250·0
733	2714·8	762	2822·2	791	2929·6	820	3037·0	849	3144·4	878	3251·9

Table 15.—CUBIC YARDS IN 100 FEET LENGTH.

Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.
·5	3253·7	899	3329·6	·5	3405·6	940	3481·5	·5	3557·4	981	3633·3
879	3255·6	·5	3331·5	920	3407·4	·5	3483·3	961	3559·3	·5	3635·2
·5	3257·4	900	3333·3	·5	3409·3	941	3485·2	·5	3561·1	982	3637·0
880	3259·3	·5	3335·2	921	3411·1	·5	3487·0	962	3563·0	·5	3638·9
·5	3261·1	901	3337·0	·5	3413·0	942	3488·9	·5	3564·8	983	3640·7
881	3263·0	·5	3338·9	922	3414·8	·5	3490·7	963	3566·7	·5	3642·6
·5	3264·8	902	3340·7	·5	3416·7	943	3492·6	·5	3568·5	984	3644·4
882	3266·7	·5	3342·6	923	3418·5	·5	3494·4	964	3570·4	·5	3646·3
·5	3268·5	903	3344·4	·5	3420·4	944	3496·3	·5	3572·2	985	3648·2
883	3270·4	0·5	3346·3	924	3422·2	·5	3498·2	965	3574·1	·5	3650·0
·5	3272·2	904	3348·2	·5	3424·1	945	3500·0	·5	3575·9	986	3651·9
884	3274·1	·5	3350·0	925	3425·9	·5	3501·9	966	3577·8	·5	3653·7
·5	3275·9	905	3351·9	·5	3427·8	946	3503·7	·5	3579·6	987	3655·6
885	3277·8	·5	3353·7	926	3429·6	·5	3505·6	967	3581·5	·5	3657·4
·5	3279·6	906	3355·6	·5	3431·5	947	3507·4	·5	3583·3	988	3659·3
886	3281·5	·5	3357·4	927	3433·3	·5	3509·3	968	3585·2	·5	3661·1
·5	3283·3	907	3359·3	·5	3435·2	948	3511·1	·5	3587 0	989	3663·0
887	3285·2	·5	3361·1	928	3437·0	·5	3513·0	969	3588·9	·5	3664·8
·5	3287·0	908	3363·0	·5	3438·9	949	3514·8	·5	3590·7	990	3666·7
888	3288·9	·5	3364·8	929	3440·7	·5	3516·7	970	3592·6	·5	3668·5
·5	3290·7	909	3366·7	·5	3442·6	950	3518·5	·5	3594·4	991	3670·4
889	3292·6	·5	3368·5	930	3444·4	·5	3520·4	971	3596·3	·5	3672·2
·5	3294·4	910	3370·4	·5	3446·3	951	3522·2	·5	3598·2	992	3674·1
890	3296·3	·5	3372·2	931	3448·2	·5	3524·1	972	3600·0	·5	3675·9
·5	3298·2	911	3374·1	·5	3450·0	952	3525·9	·5	3601·9	993	3677·8
891	3300·0	·5	3375·9	932	3451·9	·5	3527·8	973	3603·7	·5	3679·6
·5	3301·9	912	3377·8	·5	3453·7	953	3529·6	·5	3605·6	994	3681·5
892	3303·7	·5	3379·6	933	3455·6	·5	3531·5	974	3607·4	·5	3683·3
·5	3305·6	913	3381 5	·5	3457·4	954	3533·3	·5	3609·3	995	3685·2
893	3307·4	·5	3383·3	934	3459·3	·5	3535·2	975	3611·1	·5	3687·0
·5	3309·3	914	3385·2	·5	3461·1	955	3537·0	·5	3613·0	996	3688·9
894	3311·1	·5	3387·0	935	3463·0	·5	3538·9	976	3614·8	·5	3690·7
·5	3313·0	915	3388·9	·5	3464·8	956	3540·7	·5	3616·7	997	3692·6
895	3314·8	·5	3390·7	936	3466·7	·5	3542·6	977	3618·5	·5	3694·4
·5	3316·7	916	3392·6	·5	3468·5	957	3544·4	·5	3620·4	998	3696·3
896	3318·5	·5	3394·4	937	3470·4	·5	3546·3	978	3622·2	·5	3698·2
·5	3320·4	917	3396·3	·5	3472·2	958	3548·2	·5	3624·1	999	3700·0
897	3322·2	·5	3398·2	938	3474·1	·5	3550·0	979	3625·9	·5	3701·9
·5	3324·1	918	3400·0	·5	3475·9	959	3551·9	·5	3627·8	1000	3703·7
898	3325·9	·5	3401·9	939	3477·8	·5	3553·7	980	3629·6		
·5	3327·8	919	3403·7	·5	3479·6	960	3555·6	·5	3631·5		

AMERICAN PATENTS.

List of American Patents which issued from July 15. *to August* 5, 1851, (*inclusive,*) *with Exemplifications by* Charles M. Keller, *late Chief Examiner of Patents in the U. S. Patent Office.*

18. For an *Improvement in Washing Machines;* John Boardman, Little Valley, New York, July 15.

Claim.—"I do not claim the constructing or using of a revolving wash barrel, with or without a rolling or tumbling pounder therein; but what I do claim, is the peculiar form of the revolving barrel with its fluted, semi-cylindrical recess, in combination with a pounding frame, constructed with a weighted hub and three parallel pounders, as herein described."

19. For an *Improvement in Securing Pinions, &c., of Watches in Lathes;* James M. Bottum, City of New York, July 15.

Claim.—"What I claim as my invention is, the employment of adhesive cement, for securing staffs and pinions of watches or time pieces for lathe operation, in combination with a chuck, a sliding tube, and a female centre, as described and set forth, or in any manner substantially the same."

20. For an *Improvement in Machines for Cutting Wood into Shreds, and Crimping them for Mattrass Stuffing, &c.;* Edward K. Browning, Utica, New York, July 15.

Claim.—"What I claim as my invention, is the use of the splitters with the plane iron and the holder and the movable weighted lid, or any thing which is substantially the same, combined and arranged in the plane stock, for the purpose of producing the article herein described."

21. For an *Improvement in Machines for Dressing Sisal Hemp, &c.;* Stillman A. Clemens, Springfield, Massachusetts, July 15.

Claim.—"What I claim as my invention is, the hinged jaw connected with the driving shaft, substantially as described, in combination with the cylinder to which it is hinged, and provided with a corresponding jaw, substantially as described, whereby the driving power in carrying around the substances to be dressed, clamps and holds them firmly, during the entire operation as described.

"And I also claim, in combination with the cylinder and clamp, for presenting and carrying around the substances to be dressed, as described, the knives and combs attached to one or more hinged bars, and provided with the necessary means for operating them, substantially as described.

"And I also claim, in combination with the cylinder as described, the vat of water in which at each rotation of the cylinder, the substances to be dressed, are immersed, substantially as described, and for the purpose specified."

22. For an *Improvement in Churns;* Samuel G. Dugdale, Richmond, Indiana, July 15.

Claim.—"What I claim as my invention is, the application of the spring wire, which connects the crank with the dashers, in the manner and form, and for the purpose above set forth."

23. For an *Improvement in Axle-Boxes for Journals for Railroad Cars;* Oliver N Trench, New London, Connecticut, Assignor to himself and Ebenezer Stevens, Hopkinton, New Hampshire, July 15.

Claim.—"What I claim as my invention, or improvement, is to support the case on the bearing by projections or analogous contrivances, applied to its sides, in combination with making the top plate of the case and the cap or side plate in one piece separate from the rest of the case, and holding them in place, by recesses and projections or analogous contrivances, substantially as described, the whole being to enable me to entirely dispense with the use of the screws or nuts in the construction of a railway car axle box, and thereby avoid, not only the injurious consequences which frequently result from their becoming loose, but also the necessity of that care and attention on the part of the car-man or attendant, so necessary when boxes are used, having any of their parts secured by screws."

24. For an *Improvement in Carriage Springs;* Gustavus L. Haussnecht, New Haven, Connecticut, July 15.

Claim.—"What I claim as my invention, is the employment of a semi-elliptical spring in combination with a C spring, formed by the extension of one of the arms, the combined springs thus produced, being set transversely with the axle, and attached thereto and the body of the vehicle, in the manner substantially as shown and described."

25. For an *Improvement in Buggy Tops;* Harmon Hibbard, Assignor to Jared A. Hibbard, Henrietta, New York, July 15.

Claim.—"What I claim as my invention, is the mode of connecting carriage tops with the seats by means of bearers and clasp, so that they may, with facility, be removed from one carriage body, and applied to another, in the manner substantially as described."

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26. For an *Improvement in Fire Proof Safes;* Lewis Lallie, Assignor to John W. Bates, Troy, New York, July 15.

"The nature of my invention consists in constructing my safe in part of wrought and part of cast iron, which is without bolts, or rivets, as in the usual mode; my mode of construction being to render it more secure against burglary, by rendering it secure against being broke, or drilled into."

Claim.—"Having thus described the nature of my invention, what I claim as new, is the combination of wrought and cast iron, the same forming a safe, in the manner and for the purpose substantially the same as described."

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27. For *Improved Means for Adjusting the Effective Length of Bridge Counter-Braces;* D. C. McCallum, Owego, New York, July 15.

"My invention relates to the construction of open built beams, or guides, employed in bridges and other structures of a similar nature.

"My improvement consists in a new method of lengthening or shortening the counter-braces, whereby I am enabled to produce and maintain any required downward vertical strain or deflexion upon the girders; and which method I deem far more useful in practice, than those sometimes employed of using gibs, or keys, or wedges, for that purpose."

Claim.—"What I claim as my invention, is the method of lengthening or shortening the counter braces of a girder or bridge truss, so as to produce and maintain any desired vertical strain or deflexion, of the girder or truss, by means of the counter-brace, whether all of wood, or provided with a metallic end, or sheath, the plate of metal bearing upon the metallic end or sheath, (or upon the end of the wood, when the metallic end or sheath is not used,) at the top of the girder, and the nuts and the bolts passing through the clamping pieces, the upper chord and the posts, by which the plate of metal is drawn down upon the metallic end or sheath, and the adjustment of the length of the counter-brace effected, substantially as herein described."

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28. For an *Improved Rake to Harvesting Machines;* Sylvanus Miller, Urbana, Ohio, July 15.

"My invention has reference to the guidance and operation of the rake."

Claim.—"Having thus described the nature and construction of my harvesting apparatus, what I claim therein as new, is the guide, arranged as described in connexion with the tilting roller for the guidance of the rake, in a path similar to that which it would receive from the human hand, by which it removes periodically, the grain or grass from the bed, and frees itself, by the retraction of the teeth of the rake endwise."

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29. For an *Improved Arrangement of the Flues and Water Spaces of Steam Boilers;* William E. Milligan, Troy, New York, July 15.

"The nature of my invention consists in a new arrangement of flues and water spaces within a boiler for generating steam, whereby I am enabled to present a much enlarged amount of surface to the action of heat."

Claim.—"What I claim as of my own invention, is the general arrangement of the tubes and flues of the boiler, in the manner described; that is to say, the water tubes, connected with an upper and lower tube sheet in combination with the flues of less length than the tubes, which flues are also connected with an upper and lower flue sheet, whereby two horizontal flues are formed, in such connexion with each other, by means of the vertical flues, that the product of combustion from the fire-place, shall pass into the upper horizontal flue, and thence down the vertical flues, into the lower horizontal flue; having thus the facility of parting with its heat, on the one hand, by radiation through the flues to the water spaces surrounding them; and on the other, through the tubes, to the water circulating through those; and this, whether the said tubes and flues are placed vertically or horizontally; the whole being constructed and operating substantially as herein set forth."

30. For an *Improvement in Machines for Splitting Leather;* William Panton, Milton, Massachusetts, July 15.

Claim.—"I do not claim as my invention, in connexion with the upper feed roller, the use of a lower one, such as is usually termed a spring, or pressure roller, or one having a hard or practically inelastic surface; but what I do claim as my improvement in machinery for splitting, or dressing wet hides, is the employment of an elastic surface roller, (or roller made of gum elastic or other like material, placed around an axle or shaft,) and an inelastic roller, (as feed rollers,) in connexion with the cutting knife, made either stationary, or, what is better, to have a vibratory or reciprocating motion, all substantially as herein before specified."

31. For an *Improvement in Molasses Gates or Faucets;* Erastus Stebbens, Chicopee, Massachusetts, July 15.

Claim.—"What I claim as my invention, is the arrangement of the spring, which bears the gate against the seat, said spring being arranged so as to bear against the outer edge, instead of the central part of the gate, in connexion with making the said gate separate from the lever, and to work on a projection or screw therefrom, essentially as specified."

32. For an *Improvement in Revolving Breech Fire Arms;* James Warner, Springfield, Massachusetts, June 15.

"My invention consists in the engagement and disengagement of the barrel from the stock. This is effected with great facility in my improvement, by merely slackening up a screw in the stock, attached near the end of the back strap of the barrel, when a quarter revolution of the barrel will immediately release it from the stock."

Claim.—"What I claim as of my own invention, is the arrangement for securing the barrel to the stock, viz: the combination of the stud with the notch in the back strap, and with the notch and pin as described."

33. For an *Improvement in Machines for Sawing and Dressing Staves;* Dennison Woodcock, Independence Centre, New York, July 15.

Claim.—"I do not claim the use of a cylindrical saw, as such has frequently been used, but what I do claim as my invention, is the employment of the saw, seated loose upon a pulley, so as to form an eccentric position with the same as specified, in combination with the cutters, the several parts constructed and operating together for the purposes set forth, substantially as shown and described."

34. For an *Improvement in Brick Machines;* John J. Riddle, Covington, Kentucky, July 22.

"The object of my improvement in the manufacture of brick by machinery, is to bring and maintain an equal pressure upon all parts of the brick when in the mould, and thus to avoid a disturbance of the substance of any part subsequent to pressure, and the consequent liability to crack and separate."

Claim.—"Having thus fully described the nature and construction of my improvements in brick machines, what I claim therein as new, is the block or lip, substantially as described, hugging closely the mould wheel, immediately behind its point of contact with the pressure roller, in order to prevent any disturbance of the mass after having passed the point of contact."

35. For an *Improvement in Combined Fountain and Evaporator;* George H. Thatcher, Albany, New York, July 22.

Claim.—"Having thus described my invention and improvement, of a self supplying evaporating fountain, what I claim therein as new, is constructing a vase, or other like article, with two apartments or chambers, having a continuous as well as a periodical communication with each other, by which it is rendered a self-supplying, evaporating fountain, the continuous communication of the lower chamber with the upper apartment or evaporator, being effected by the pressure of steam upon the surface of the water in the lower chamber, and the periodical communication, by means of the valve secured in the screw-nut, which will be opened by the pressure of the accumulated water in the upper apartment, when relieved of the pressure of the steam in the lower chamber, as fully described and represented."

36. For an *Improvement in the Mode of Changing Reciprocating into Rotary Motion;* Joel V. Strait, Litchfield, Ohio, July 22.

Claim.—"What I claim as my invention, is, 1st, the employment of curved or inclined forks, having a reciprocating rectilineal movement operating on or operated by cams, in the manner and for the purposes herein set forth.

"2d, The use of cams constructed or attached, so that they may be turned or set, in order to produce a change in direction of the motion, and acting in connexion with forks, or their equivalents, substantially for the purposes expressed, as shown and described."

37. For *Improvements in Hanging Carriage Bodies;* John Jones, Clyde, New York, July 22.

Claim.—"Having thus fully described my invention, what I claim therein as new, is the manner herein described, of raising the body on to the springs, or lowering it on to the reaches, as may be desired, and for the purposes herein fully set forth."

38. For an *Improvement in Buffing Apparatus for Daguerreotype Plates;* William and William H. Lewis, City of New York, July 22.

Claim.—"We do not claim heating the buffer, as that has been done by lamps, operating on the plate on which the buffing material is stretched; but in that form the heat is uneven and the vapor from the spirit lamp is liable to come in contact with the buffing material; but what we claim as new, and of our own invention, is the enclosing drum, constructed with the sliding segment, or cover, flanch, and lip, sliding in the grooved plate, and retained by the spring for the purposes specified, in combination with the drum, and pipe, to pass the heat from a spirit lamp, or other heater, to the drum, for the purpose of heating the buffer; the drum being fitted with a pipe or other means to pass any vapor from the spirit lamp outside the case enclosing the buffer, substantially as described and shown."

39. For *Improvements in Hanging Carriage Bodies;* John Jones, Clyde, New York, July 22.

Claim.—"Having thus fully described my invention, what I claim therein as new is, 1st, the combination herein described, of the turning compensating plate, with the rock shaft and the connecting rods, for the purpose of equalizing the action on the helical spring.

2d, I claim the stop lever in combination with the turning plate, used in fastening down the body, substantially in the manner herein described.

"3d, I claim the stays, for the purpose of keeping the axle trees in their true set, or upright position, as herein described and fully set forth."

40. For an *Improvement in Faucets;* Charles W. Stearns, Springfield, Massachusetts, July 22.

Claim.—"What I claim therefore as my invention, is the application of a hollow conical packing around the waist of the valve stem, in combination with an open space between its lower end and the stem; the interior of the tubular projection being smooth, or of such form as to allow a tight joint between it and the conical packing, substantially as above described."

41. For an *Improvement in Saddle-Trees for Harness;* James A. Lawrence, Assignor to Roberts & Lampson, New Haven, Connecticut, July 22.

"The nature of my invention consists in constructing a pad-tree in such manner, that the pad-iron can be adjusted and secured at any required angle from the yoke, so as to fit easily the back of the horse on which it is placed."

Claim.—"I do not claim as my invention the yoke, the turrett, or the pad-iron, separate from each other; but what I do claim as my invention, is the combination and arrangement of the yoke, the turrett, and the pad-iron, in such manner that the pad-iron may be adjusted at any angle required for use, and immediately secured firmly in its place, by a screw on the terrett-iron, passing through the yoke into the pad-iron, substantially as shown in the drawings, and herein set forth."

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42. For *Improvements in Pumps for Raising Water, &c.;* Joseph F. Flanders Newburyport, Massachusetts, July 22.

Claim.—"What I claim as my invention or improvement, is as follows: I claim the rod, and its arms or other equivalent contrivances, and its valve collar, as applied to or combined with the rod of the lower box, and the valve or valves, made to operate therewith, substantially as above set forth."

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43. For an *Improvement in Cloth Folding Machines;* D. R. Ambrose, Portsmouth, New Hampshire, and O. L. Reynolds, Dover, New Hampshire, July 22.

Claim.—"What we claim as our invention, is the measuring and folding of cloth. paper, and other articles, by means of two revolving cylinders, each of which is provided with a tongue and jaws, the tongue to feed the cloth into the jaws, which seize it and form the fold and deliver it upon the table, leaving it properly measured and folded."

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44. For an *Improvement in Flour Bolts;* Samuel Cook, Adams' Basin, New York, July 22.

Claim.—"Having thus fully described my invention, what I claim therein as new, is the combination and arrangement of the inclined boards, with a case of graduated screens, constructed and arranged substantially as herein described and represented, and for the purpose specially set forth."

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45. For an *Improvement in Parlor Cooking Stoves;* N. A. Boynton, Boston, Massachusets, July 22.

"My improvements consist in the arrangement of flues about the oven, by which the heat, smoke, &c., is made to pass about both the sides, and the top and bottom of said oven, the end or part of the oven most remote from the fire chamber, being heated, as well as the part adjacent to said fire chamber."

Claim.—"Having thus described my improvements in parlor cooking stoves, I shall state my claim as follows:

"What I claim as my invention, is the arrangement of flues, as herein above described, about the oven of a parlor cooking stove, by which the heat, smoke, &c., is first made to pass over the top of the oven, and then down the passage formed between the front side plate and the side of the oven, across the bottom of the oven, up through the passage formed between the rear side plate and the other side of the oven, and finally out through the smoke pipe; the heat, &c., being made to pass to the part of the oven most remote from the fire chamber, by the partitions on the top and bottom of said oven, substantially as herein above described."

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46. For an *Improvement in Mills for Grinding Corn and Cobs;* Sidney A. Bantz and William Andrew, Frederick, Maryland, July 22.

"Our mill is constructed to grind substances by means of toothed cylinders, which work in connexion with corresponding toothed concaves; and our improvement consists in a device, by means of which the substances introduced into the hopper, are chopped or broken into coarse fragments, and are then fed to the grinding apparatus."

Claim.—"What we claim as our invention is, the chopping and feeding apparatus, constructed and operating as herein described, in connexion with a grinding apparatus.

"We also claim the recess in the concave, which prevents the escape of fragments, when struck by the teeth of the cylinder."

47. For *Improvements in Carriage Springs;* M. G. Hubbard, Rochester, New York, July 22.

"My improvement consists in forming a spring of a straight bar of steel, of proper dimensions, and equal thickness throughout, attaching it to the carriage so as to be compensating and self adjusting to any weight that the carriage is capable of sustaining, by which means I form a durable, cheap, and efficient spring of great lightness, that cannot be set or made to strike, when brought entirely down to its bearing."

Claim.—"Having thus fully described my improved spring reaches for carriages, what I claim therein as new, is the combination of the rockers and spring bars of a carriage, substantially as herein set forth, and for the purposes described."

48. For *Improvements in Stave Dressing Machines;* William Hawkins, Milwaukie, Wisconsin, July 22.

Claim.—"Having thus fully described my invention, what I claim therein as new, is, the arrangement for starting each stave, or introducing it to the feed at the proper moment, consisting of the wheel, with its stud, the bent lever, the pitman lever, shaft lever, sliding rod, spring, and adjustable starting bar, in combination with the apparatus for giving the reciprocating motion to the jointing cutters, so that the greatest width of the stave may be given on different lengths of stave uniformly at the middle, or such other point as may be desired; the whole being combined, arranged, and operated, in the manner substantially as herein specified."

49. For an *Improved Machine for Dressing Boot Forms;* Joseph Burgess, Leicester, Massachussets, July 22.

Claim.—"What I claim as my invention is, the circular motion of the cutters attached to one end of a lever, the other end being so confined on the oppposite side of the boot form, as to allow the cutters to play up and down, and dress one or both sides of a boot form at a time, as herein set forth."

50. For an *Improvement in Feather Edging Gauges for Shoemakers;* Jacob Jenkins, Andover, Massachusetts, July 22.

Claim.—"What I claim as my invention is, the arrangement of the adjustable gauge rest, the pressure roller and knife, or cutter, in the case or handle, substantially as described, and so as to constitute a tool for feather edging, or reducing soles of shoes, as specified."

51. For an *Improvement in Bran Dusters;* Solomon W. Kirk, Coatesville, Pennsylvania, July 22.

Claim.—"I do not claim exclusively, the employment of intermediate vanes, acting in connexion with the brushes on the reel for forming a blast, as such have already been used; but what I do claim as my invention, is the employment of adjustable vanes, which may be set in or out, and obliquely in direction of their length, or be set either way only, as described and represented by the vanes lettered *f g* in the drawing; such adjustable vanes acting in combination with the brushes on the reel, for the purposes and in the manner substantially as set forth."

52. For an *Improvement in Dyeing Door Mats;* Reuben Shaler, Madison, Connecticut, July 22.

"The nature of my invention consists in coloring the wool upon lamb skins, with a variety of colors upon each skin, or with one color on certain parts of the skin, leaving the remainder white. Either the colors or the white parts of the wool may be made to represent flowers, or any figures which the operator may design."

Claim.—"What I claim as my invention is, the coloring of borders and figures, in a variety of colors and forms, upon the wool of lamb skins and sheep skins, for mats and other similar purposes, by the use of pans, (which are to contain the dyes,) being made and shapened in the form of the borders or figures designed to be colored, in combination with the matching tin or form, or an equivalent device for parting the wool, substantially in the manner and for the purpose herein set forth."

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53. For an *Improvement in Machines for Preparing Hubs for Boxes;* William R. Jones, Granville, New York, July 22.

Claim.—"Now what I claim as new, is the combination of the movable cutters with the saws and small pins, arranged and operating substantially in the manner and for the purpose herein described.

"I do not claim the cutter singly, or the arbor or disk, or the saw, such things having been used separately before."

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54. For an *Improved Method of Liberating Metal Tubes from Forming Mandrel;* Job Cutler, Birmingham, England, July 29; patented in England, February 28, 1849.

"My invention relates to improvements in the manufacture of metallic pipes or tubes, which have hitherto generally been brazed, or soldered, and cold drawn, and with a seam or joint."

Claim.—"Having now described the nature of my said invention, and in what manner the same is to be performed, I wish it to be understood. that I do not claim the exclusive use of the rolls for cross rolling, herein before described and represented, except when the same are employed in the manufacture of pipes or tubes of copper, brass, or other alloys of metal, as herein described, to be used as the flues of steam boilers; but what I do claim in the manufacture of pipes or tubes of brass, copper and alloys of metal, for the use as the flues of steam boilers, by rolling hot on a mandrel, whether parallel or taper, is the enlarging of them, by means of cross rolling, as above described, for the purpose of extracting the mandrel."

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55. For an *Improvement in Oil Cups for Journal Boxes;* Aaron Richardson, Bellows Falls, Vermont, July 29.

"My invention consists in providing the interior of the oil cup with a valve, which fits in a seat around the mouth, and is held there by a spring, serving to close the mouth of the cup, and exclude dirt, but yielding to the slightest pressure of the spout of an oil can or feeder, and allowing the oil or other lubricating material to be introduced, closing itself when the pressure is removed, and forming in fact a self acting stopple."

Claim.—"What I claim as my invention is, the employment within the mouth of an oil cup of a valve operated upon by a spring, or its equivalent, in the manner and for the purpose substantially as herein described."

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56. For an *Improvement in Fly Traps;* Harvey Snow, Lowell, Massachusetts, and Luther T. Smart, Campton, New Hampshire, July 29.

Claim.—"What we claim as our invention is, the tube in combination with the glass and the bottom, and rod, for the purpose above described, meaning to vary the construction while keeping the fixture substantially the same.

"We also claim the ring which is to close the apertures in the bottom, for the purpose to which it is applied, or any thing similar in its application."

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57. For an *Improvement in Cut-Off Gear;* George H. Corliss, Providence, Rhode Island, July 29.

Claim.—"In combination with the reciprocating motions communicated to the lifting rods, by the eccentric gear, I claim imparting a lateral movement to the free extremities of said lifting rods, to disconnect them from the valves, and permit the latter to close, to cut off the steam, or other expansive fluid, by which the engines may be driven, whereby these rods are made to perform their usual duty of opening the valves, and, in addition, that of catches, or latches, in alternately connecting the valves with, and disconnecting them from, the mechanism by which they are opened, thus greatly simplifying the construction of the valve gear, rendering the same more durable and lesss liable to get out of order."

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58. For an *Improvement in Flexible Fences;* Matthias P. Coons, Lansingburg, New York, July 29.

"The nature of my invention consists in an improved mode of connecting and attaching panels of banister or picket fence, or railing, to each other and to a post; and, by the same device, the said fence or railing may be placed or erected on any and all grades of undulating surface, and all variations of course."

Claim.—"Having thus fully set forth and described the nature of my invention, and its practical operation, I do not claim any particular form or construction of a part in connexion herewith, the same not being essential; nor whether the same be of wood, or any other substance, (I having heretofore invented a metal post, being a convenient device to use in connexion herewith;) but what I do claim as my invention, is the form and construction of the two concave plates, with pins near their open ends, forming one coupling cap or clasp, for the purpose of uniting together the upper bars of fence or railing, whether the same be of wood or metal, and also, of securing the same by the use of a pin with a screw thereon, or other device, on the top of a post, in the manner and for the purpose as herein described.

"And in connexion therewith, I claim perforating the bars or rails, with conical or tapering holes, mortises or orifices, for the insertion of pickets or banisters, in the manner and all for the purpose as is herein substantially set forth and described."

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59. For an *Improvement in Cast Iron Car Wheels;* Thomas J. Eddy, Waterford, New York, July 29.

Claim.—"What I claim as my invention is, 1st, a cast iron car wheel, made with a hollow chilled rim, and hollow spokes, in the manner and form herein set forth.

"The method of forming wheels for railroad cars, by casting the rim and spokes upon a grooved hub, which has been formed separately, as herein described."

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60. For *Spring-Expanding Swage for Boiler Tubes, &c.;* James McCarty, Reading, Pennsylvania, July 29.

"My invention consists of an expanding swage, composed of sections, which are connected together and to a common centre, by spring shanks, in such manner, that while the several sections preserve their relative angular positions, they may be forced outwards from the axis of the tool, by means of a conical plug, so as to expand a tube in which the tool is inserted."

Claim.—"What I claim as my invention, is an expanding swage, constructed as herein set forth, and consisting, essentially, of radiating sections, which are connected with each other, and to a common centre, by spring shanks, as herein described."

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61. For an *Improved Powder Proof Bank Lock;* Wm. Hall, Boston, Massachusetts, July 29.

Claim.—"Having thus described my improvements in locks, I shall state my claim as follows: what I claim as my invention, is moving the key-bit to the tumblers by means of a follower, sliding between walls, as herein described, which follower acts in such a manner as to close the space into which powder might be introduced, where this is combined with a key hole cover, sliding as described, by which combination I make a powder proof lock, with tumblers, which cannot be reached by a pick, and whose slide cannot be blown off, so as to secure access to the tumblers.

"I also claim the combination with the plate of the transverse sliding vertical slotted plate, which jointly cut off all communication with the tumblers, in every position of the bolt."

62. For an *Improvement in Window Sashes;* Sewall Short, New London, Connecticut July 29.

"My improvement consists in so constructing the bars of the sash, as to enable me readily to set a pane or panes of glass without putty, and in a manner perfectly water-tight; the process being so simple, that any person can readily perform it; thus saving all the labor and expense of glazing in the ordinary way, or removing the sash from its place for the purpose."

Claim.—"Having thus fully described my improved method of setting glass, what I claim therein as new, is fastening the bars of two parts, as herein described, by binding them together by a screw at the junction of their ends, their opposite ends being hooked into the frame of the sash, substantially in the manner and for the purpose set forth, and in combination with this device, I claim the elastic bed for the glass to rest against, as above specified."

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63. For an *Improvement in Machines for Grinding Flock;* John C. Fonda, Albany, New York, July 29.

Claim.—"I do not limit myself to grinding or cutting flock, but any article to which the machine can be advantageously applied. I claim a cylinder, or drum, with knives or beaters attached, extending its length, said knives being set at an oblique angle, both with the radial lines and the axis of the drum, in combination with an outer cylinder, within which the drum revolves; the outer cylinder also revolving in an opposite direction, and having on its inner surface at intervals, knives extending its length, the said knives being parallel with its axis, but oblique to its radius; said outer cylinder also having in the intervals between its knives, panels containing projecting ribs, oblique to its axis, and so arranged that the action of the revolving knives upon any material lying between the ribs, shall gradually carry it from the inner to the outer end of said cylinder; thus subjecting the material to repeated cuttings between the revolving knives, substantially as set forth in the above specification.

"I claim the method of constructing the outer cylinder of alternate panels; the one set being permanent, and having on its inner surface, oblique ribs, the other set being movable and adjustable, (these panels are called cross bars in above description,) by screws and springs, and having on its inner surface, oblique knives; the fixed panels being connected with an outer and concentric ring of metal, by chambers or passages, the same being in combination with another cylinder or ring of metal, within which it fits and revolves, which last ring has a hopper upon it, to receive the material to be operated on, opening into the said chambers or passages, and by them into the cylinder containing the knives, substantially as set forth in the above specification.

"I claim the combination of outer and inner rings, with the inner and outer revolving cylinders and their knives and ribs, making a machine for grinding flock, or any other material, substantially as set forth and described in the above specification."

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64. For *Improvements in Knitting Machines;* John Henry Barsantee, Portsmouth, New Hampshire, July 29.

"The principal part of my improvements consists in the movable yarn carriers, which are made separate and independent, one for each needle, and having a sliding motion given to them in and out, they perform the part of the "jacks" in ordinary stocking looms."

Claim.—"Having thus described my improvements, what I claim as new therein, is, 1st, the sliding independent yarn carriers, each governing an independent thread for each needle, substantially in the manner and for the purpose as described.

"2d, I claim operating the yarn carriers, simultaneously, by means of the conical ring, working in the inclined slit in the carriers, substantially as set forth."

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65. For an *Improvement in Stoves with Portable Ovens;* George H. Thatcher, Albany, New York, July 29.

"The nature of my improvements consists in constructing a portable oven with a continuous flue, in such a manner as to unite with the fire chamber of the stove, and receive the heat therefrom, and conduct it over the top and down the rear side of the same, and permit it to pass thence into the upper flue, in the usual manner."

Claim.—"Having thus described my improvements in the portable oven, for cooking stoves, what I claim therein as new, is in combination with a portable oven, the permanent damper plate, or shut off, which forces the heat and smoke, after striking against the bottom of the oven, to pass up the front flue and over the oven, and then down the back, passing down behind the permanent damper plate or shut off, and out through the ordinary draft, or top flue of the stove; being so simple in its construction, that it may be made by an ordinary tin-man, to suit any ordinary stove, as described and represented."

66. For an *Improvement in Seeding Apparatus of a Seed Planter;* David Horner, Knox County, Ohio, July 29.

"My improvements have reference to two objects; first, to the equable distribution of manure; and second, to the certain and equable distribution of seed."

Claim.—"What I claim as my invention, is the combination of the measuring seed roller with the distributing seed roller, the two being arranged and operated in the manner and for the purpose herein described."

67. For an *Improvement in Machines for Preparing Hubs for the Reception of Boxes;* Henry Moore, Seneca County, Ohio, July 29.

"The nature of my invention consists in providing an auger, and box-setter, for the purpose of boring the hubs and setting the boxes of wagon, carriage, railway car, and other vehicle wheels."

Claim.—"What I claim as my invention, is the sliding shaft, with the slot marked, passing longitudinally into the mandrel, together with the screw thread cut upon the mandrel to feed the knives, and the knives, which are so adjusted as to act at both ends at the same time, and also cross stays, similar in construction (which may be formed of wood,) to those marked 1 and 2 in the above description, which are intended for the purpose of fastening and truing the hub; all of which will appear by the above description, except the cross stays, for the purpose of securing and truing the hub, during the process of boring."

68. For *Improved Fittings for Boats, to Facilitate the Discharge of Cargo, &c.;* William H. Bryan, Georgetown, D. C., July 29.

Claim.—"What I claim as my invention, is the cargo deck, formed of loose, narrow sections, so that it may be removed, to adapt the vessel to carrying cargo in packages, or may be put in place, to facilitate the unlading of cargo in bulk, in combination with the railway on the floor, for transporting the lading to the point whence it is removed from the hold."

RE-ISSUES FOR JULY, 1851.

1. For an *Improvement in Steam and Vacuum Gauges;* Paul Stillman, City of New York; patented May 9, 1848; re-issued July 29, 1851.

Claim.—"What I claim as my invention, is, 1st, the combining with the reservoir of mercury at the lower end of the tube, an elevated chamber forming part of the reservoir substantially as herein described; so that the zero point may be high enough to be visible above the reservoir as herein described, and also that the air contained in the tube being condensed by the pressure of the mercury in the elevated chamber, may furnish more desirable divisions on the scale, when very high pressures are to be indicated.

"2d, The producing a partial vacuum in the tube of the steam gauge at the time of filling it with mercury, for the purpose of bringing the zero point high enough to be visible above the reservoir, and also in order to prevent any partial vacuum produced in the boiler from drawing all the mercury out of the tube.

"3d, Surrounding the lower end of the glass tube with a metallic cylinder, provided with a cap or plug at its lower end for protecting the glass tube, and allowing the mercury only to pass slowly, either through a very small hole or between the threads of the screw, and the establishing a connexion between the reservoir and the boiler, substantially in the manner and for the purpose above specified.

"4th, The method of preventing the air or moisture from passing between the mercury and the cylinder into the tube, either by turning the cylinder or washing it with mercury, or by plunging it deeply into the mercury as above described.

"5th, Preventing the inside of the tube from being soiled with oxidised mercury, by either placing on the surface of the mercury in the tube some fluid (such as naphtha) which does not act perceptibly upon mercury, or by filling the tube with gas as herein made known."

2. For *Improvements in Fastenings of Scythes to the Snath;* E. S. Clapp, Montague, Massachusetts; patented March 18, 1851; re-issued July 8, 1851.

Claim.—"What I claim as my invention, is, 1st, the mode of attaching and securing the blade of the scythe to the snath, substantially as herein specified, to wit: by clamping its shank between the edges of an aperture, in the end of a metal cap secured to the snath, and two bearings or points on the opposite side of the shank, and on opposite sides of the first named bearing point, one of the two bearings consisting in a screw or its equivalent, for the purpose of giving the necessary pressure to clamp it.

"2d, The method substantially as herein described, of setting the edge of the blade more up or down, by means of the adjusting screw, in combination with the edge of the aperture, which forms one of the three bearing points of the shank."

DESIGNS FOR JULY, 1851.

1. For a *Design for Cooking Stoves;* John F. Rathbone, Albany, New York, July 8.

Claim.—"What I claim as my production, is the combination and arrangement of ornamental figures and forms, represented in the accompanying drawings, forming together the ornamental designs for the plates of a cooking stove."

2. For a *Design for Stoves;* William C. Davis, Cincinnati, Ohio, July 8.

Claim.—"Having described and represented my ornamental design for stoves, I wish it to be understood that I do not claim the radiating ornaments or the mouldings, separately considered, but what I do claim, is the combination of the ornaments as described and represented."

3. For a *Design for Parlor Stoves;* Joseph Pratt, Boston, Massachusetts, July 8.

Claim.—"Having thus described my new design, I shall state my claim as follows: I claim the design consisting of the ornamental configuration, flower and leaf work herein above described and represented in the drawings, respectively, for the top and bottom plates of a parlor stove."

4. For a *Design for Water Coolers;* William Burnet, Cincinnati, Ohio, July 8.

Claim.—"What I claim as my design, is, 1st, the form and general configuration of the outer casing, substantially as described and represented in the drawings.

2d, The dolphin spout, and, 3d, the configuration of the handle of the cover, substantially as shown."

5. For a *Design for Stoves;* James V. De Witt, Buffalo, New York, July 8.

Claim.—"What I claim as new, is the design and configuration of ornamental stove plates, as herein described and represented in the annexed drawings."

6. For a *Design for Stoves;* S. W. Gibbs, Albany, New York, Assignor to North, Harrison & Chase, Philadelphia, Pennsylvania, July 8.

Claim.—"What I claim as my invention is the arrangement of the ornaments and mouldings herein described, as constituting a design for cooking stoves."

7. For a *Design for Plates of Franklin Stoves;* John F. Rathbone, Albany, New York, July 8.

Claim.—"What I claim as my production is the combination and arrangement of ornamental figures and forms represented in the accompanying drawings, forming together the ornamental designs for the plates of a Franklin stove."

8. For a *Design for Cooking Stoves;* John F. Rathbone, Albany, New York, July 8.

Claim.—"What I claim as my production, is the combination and arrangement of ornamental figures and forms, represented in the accompanying drawings, forming together the ornamental designs for the plates of a cooking stove."

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9. For a *Design for Stove Plates;* Elijah P. Penniman, Rochester, New York, July 15.

Claim.—"What I claim as my invention, is the ornamental design or production represented by figures 2 and 4, and to be used with the carving represented by letters O P."

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10. For a *Design for Stove Plates;* Elijah P. Penniman, Rochester, New York, July 15.

Claim.—"What I claim as my invention, is the ornamental design or production, represented by figures 1 and 3, to be used with the carving represented by letter N."

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11. For a *Design for Plates of Parlor Stoves;* Apollos Richmond, Assignor to A. C. Barston & Co., Providence, Rhode Island, July 15.

Claim.—"Having thus described my new design, I shall state my claim as follows: I claim the design, consisting of the ornamental arches, panels, and mouldings, herein above described and represented in the drawing respectively, for the front and top plates of a parlor stove."

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12. For a *Design for Cast Iron Tomb;* Henry K. Flinchbaugh, Conestoga, Pennsylvania, July 22.

Claim.—"What I claim as my invention, is the ornamental design for cast iron "Cemetery Tomb," ornamented as herein described."

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13. For a *Design for Stoves;* Reuben J. Blanchard, Assignor to B. P. Learnard and G. H. Thatcher, Albany, New York, July 29.

Claim.—"What I claim as my invention, is the ornamental designs for ornaments upon cast iron stove plates above described, and more fully shown in the annexed drawings."

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14. For a *Design for Stoves;* Reuben J. Blanchard, Assignor to B. P. Learnard and G. H. Thatcher, Albany, New York, July 29.

Claim.—"What I claim as my invention, is the ornamental design for cast iron stove plates, shown in the annexed drawings and above described."

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15. For a *Design for Stoves;* Reuben J. Blanchard, Assignor to B. P. Learnard and G. H. Thatcher, Albany, New York, July 29.

Claim.—"What I claim as my invention, is the ornamental design above described and delineated in the annexed drawings, as an ornament for the plates of cast iron stoves."

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16. For a *Design for Stoves;* Nicholas S. Vedder, Assignor to A. T. Dunham & Co., Troy, New York, July 29.

Claim.—"What I claim, is the design and configuration of ornaments as applied to stoves, substantially the same as described."

AUGUST.

1. For an *Improvement in Tight Joint for Tuyeres;* Wm. Graham, Carlisle, Pennsylvania, August 5.

"The nature of my invention consists in the arrangement of the inner and outer beads on the top plate, between which is placed clay, or other plastic material, and the grooves in the edges of the sides of the tuyere, for the purpose of making an air tight joint; the whole being secured by bolts with projections upon them, catching over a cam cast on the flanches, on the under plate."

Claim.—"Having thus fully described my invention, what I claim therein as new, is, the combination of the inner and outer beads on the top plate, between which is placed clay, or other plastic material, and the grooves in the edges of the sides of the tuyere, for the purpose of making an air tight joint; the whole being secured by bolts, with a projection on them, catching over a cam cast on flanches on the under plate, as herein described and represented."

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2. For an *Improvement in Brick Machines;* Luther Brown, Canandaigua, New York, August 5.

"The object of my improvement is to produce a portable brick machine, which can be worked either by hand or horse power, and one which will require but few hands to manage, and at the same time do its work rapidly and well."

Claim.—"Having thus described my improvements, what I claim as new therein, is, 1st, the arrangement of the apparatus for moving the moulds and the pressing apparatus, all constructed substantially as herein described, and worked by the revolving shaft in the manner and for the purposes set forth."

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3. For an *Improvement in Grain Winnowers and Harvesters;* Augustus P. Childs, Rochester, New York, August 5.

"The object of my improvement is to effect the more thorough separating and cleansing of grain from the straw and impurities with which it is mingled, when discharged from a threshing machine, and also to simplify the construction of the apparatus, as well as to increase its efficiency."

Claim.—"I claim the elevator, constructed substantially as herein set forth, with oblique plates or blocks, to support the straw, and facilitate the separation of the grain.

"I also claim the arched grating, in connexion with a blast, to effect the separation of the lighter impurities from the grain.

"I likewise claim the arrangement, substantially as herein described, of the air chamber between the fans, the suction pipe to supply the chamber with air, and the spout to conduct the once winnowed grain from the screw into the lower extremity of the suction pipe, to be winnowed a second time by the entering current of air, whereby the grain is subjected to the full force of two independent blasts, acting consecutively, which insures its effectual winnowing, as herein set forth."

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4. For an *Improvement in Brick Machines;* James Dane, Darius Healy, and Garry Cumings, Assignors to Isaac and Francis Dane, Derby, Vermont, August 5; antedated, June 17, 1851.

Claim.—"What we claim as our invention, is, 1st, the arrangement of mechanism, substantially as herein described, viz: the toothed wheel, and the cams operated by the changing gear or the equivalent thereof, connected with the mill, so as to be moved alternately back and forth, for the purpose of operating the mould carriage and the pressing piston, substantially in the manner herein set forth.

"2d, We also claim the adjustable rod or its equivalent, connected with the piston rod for the purpose of acting upon the catch lever, or its equivalent, so as to disengage the weight or its equivalent, by which the operating machinery is thrown out of gear, for the purpose of arresting the pressing motion as soon as the piston has been depressed far enough to fill the moulds.

"3d, Is the circular projection or its equivalent, upon the wheel, to throw the wheel out of gear, and stop the moulding apparatus, while the grinding proceeds."

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5. For an *Improvement in Dressing Mill-Stones;* Moore Holden, Lawrenceburgh Indiana, August 5.

Claim.—"Having thus fully, clearly, and exactly described the nature, construction and operation of my invention, being an improvement in dressing millstones, what I claim therein as new, is, the dress given to millstones, according to the definite and fixed rules described in the foregoing specification, and illustrated in the drawing by the furrows of each quarter.

"I also claim diminishing the draft of the runner, and increasing the number of the quarters, in comparison with that given the bed stone, for the purpose of giving the furrows of each stone, as determined by the rule laid down in the specifications, a shears motion upon each other."

6. For an *Improved Water Level Indicator for Steam Boilers;* Albert H. Jadd, Marinetown, Illinois, August 5.

Claim.—"What I claim as my invention is, the connecting the ordinary float, placed within a steam boiler, with an index placed on the outside of the same, through the medium of the valve of a gauge-cock, by which I am enabled to remove any impurities which may at any time hinder the effective action of the float, substantially as herein set forth."

7. For an *Improvement in Shutters for Shop Fronts;* James Root, Cincinnati, Ohio, August 5.

Claim.—"Having thus fully described my improved shutter, what I claim therein is, in combination with the sliding shutter, substantially as above described, the door, by which it is fastened, and which permits it to slide back."

8. For an *Improvement in Metallic Alloy Paints;* Charles Wetterstedt, Marseilles, France, Assignor to Charles Keenan, City of New York, August 5; patented in England, Nov. 3, 1846.

"The basis of my invention consists in the combination or mixture of regulus of antimony, in various proportions, purified from all ferruginous particles, with copper, tin, zinc, or lead. These mixtures reduced to impalpable powders, are combined with suitable vehicles to form paint, and spread on the surfaces to be preserved."

Claim.—"Having thus described my invention, what I claim as new is, making paints out of metallic antimony, whether prepared separately, or combined with other metals, to form alloys suitable for making paints, substantially as herein set forth.

"2d, I also claim combining antimonial alloys with oxide of copper, to constitute with the painting vehicles herein specified, the exterior coatings for ships' bottoms, for the purpose of more effectually defending them against the adhesion of shells and weeds, substantially as herein set forth."

9. For an *Improvement in Hot Air Furnaces;* Joseph C. Treat, East Hartford, Connecticut, August 5.

Claim.—"What I claim as my invention, is the employment of a flue or chamber, having a valve and apertures, in combination with an internal flue, constructed and operating substantially as shewn and described for the purposes set forth."

10. For an *Improvement in Quadrant Hinged Grates;* George H. Thatcher, Albany, New York, August 5.

Claim.—"What I do claim as new and of my own invention, is suspending the quadrant grate by pivots projecting from the ends thereof, near the centre of the circle of the grate, in such a manner, that when it shall be desired to discharge the contents from the grate, its rear and lower portion will be made to recede from the back wall and rise in the throat of the chimney, and thus the contents will be discharged into the rear portion of the fire place, and the dust carried directly up the chimney, and the grate moving outward, having to drag through the accumulated coal, ashes, &c., in the fire place, as described.

"I also claim the combination of the guard plate with the quadrant grate, said guard plate projecting from the back of the fire place horizontally above the lower rear edge of the grate, and vertically within the ends of the same, for the double purpose of forming a support for the fire brick, or back of the grate, and protecting the inner edges of the bottom and ends of the grate, and preventing it from being opened by the lumps of coal, that would otherwise fall between its edges and back wall, and force the grate open as described."

11. For an *Improvement in Shuttle Motions of Looms;* George J. Wardwell, Hanover, Maine, August 5.

Claim.—"What I claim as my invention is, operating the picker staff or staves, by a cam or cams, upon a shaft, hung in bearings, attached to the lay, and carrying a ratchet wheel, which receives motion, at suitable intervals, through an arm, worked by the same motion which operates the lay, substantially in the manner herein described."

12. For an *Improvement in Machines for Taking Ayes and Noes;* G. William Yerby, Washington, District of Columbia, August 5.

Claim.—"Having thus fully described my improvements, what I claim therein as new, is the peculiar form and action of the springs which carry the pencil, by which a draw mark is made, without risk of breaking the point."

13. For an *Improvement in Working Clay for Pottery and other Ware;* John Akrill, Williamsburgh, New York, August 5.

Claim.—"Therefore, what I claim as my invention, is the application of heat to clay, during the process of mixing, working, and tempering the clay, so that it is raised to a heat at or about the boiling point of water, at the time of moulding or forming the same, substantially as described and shown."

14. For an *Improvement in Looms for Weaving Pile Fabrics;* John Johnson, Assignor to Elias Johnson, Troy, New York, August 5.

Claim.—"Having thus set forth the principle of my invention, and the manner of constructing and using the same, I wish it to be understood, that I do not limit myself to the special construction and arrrangement of parts herein specified, as these may be varied, without changing the principle or mode of operation; what I claim as my invention, is the employment on one or both sides of the loom of two carriers, to which the figuring wires are secured, and two guides, substantially as described, and operated alternately; the said carriers having a motion towards and from the selvedge of the cloth, to draw out and insert the wires, and together with the guides, a motion towards and from the lay, to carry the wires from the woven pile to the open shed and back, as described.

"And I also claim, in combination, giving to the guides a vertical movement, after the wire has been drawn out, to admit of their passing each other, substantially as specified."

15. For an *Improvement in Seiwng Machines;* Wm. H. Akins and Jacob D. Felthousen, Ithica, New York, August 5.

Claim.—"Having thus fully described our invention, what we claim therein as new, is, 1st, the combination and arrangement of the pitman, driving bar, shuttle, and adjustable set screw, for the purpose of allowing the pitman a continuous motion, whilst the shuttle bar and shuttle is momentarily stopped, to allow the needle to draw up the stitch, as herein described and represented.

"2d, We claim bringing up the needle with a sudden jerk, after the stitch is formed, for the purpose of tightening up the stitch, after the manner of hand sewing, and adjusting the same to any thickness of material to be sewn."

16. For an *Improvement in Looms for Weaving Cut Pile Fabrics;* Mertoun C. Bryant, Lowell, Massachusetts, August 5.

"The first part of my invention consists of a method of holding and supporting the warp threads, in order that the filling may be properly drawn in at the edges of the cloth to make smooth selvedges.

"The second part of my invention consists of a method of holding the filling thread in the place where it is left by the reed, when it is beaten up into the cloth.'

Claim.—"What I claim as my invention, is 1st, the use in looms, of a finger or shield, which shall be introduced between the warps, for the purpose of bringing the warp threads at the edge of the cloth, in such a position, that the filling yarn will be drawn in to form a smooth selvedge, substantially as described.

"2d, The use of hooks, formed on the intersecting plates, or their equivalents, which shall hold the filling thread from returning towards the reed, substantially as described."

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17. For an *Improvement in Brick Machines;* Isaac Gregg, Pittsburg, Pennsylvania, August 5.

Claim.—"What I claim as my invention, is the placing the auxiliary pressure roller, or its equivalent, between the main roller and the knife, for the purpose of subjecting the surplus clay, after it is elevated above the tops of the moulds, to the action of pressure, before removing the same by the said knife, substantially as herein set forth.

"I also claim the subjecting the upper surface of the clay in each mould, to a rubbing pressure by means of a plate or its eqiuvalent, placed above the tops of the moulds, in combination with some mechanical device for forcing up the movable bottoms of the said moulds, whilst passing under the said plate, substantially in the manner and for the purpose herein set forth."

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18. For an *Improvement in Printing Presses;* George P. Gordon, City of New York, August 5.

"The nature of my invention consists in arranging a platen, which vibrates upon a centre, so as to carry the face in an arc of a circle, to and from the points or places of receiving the sheet of paper and the impression at the proper times; also in adapting the same to receive the sheet of paper between said platen, and a frisket with adjusting nippers; as well as a proper arrangement of bed, inking rollers, etc., all of which is hereinafter fully described and set forth."

Claim.—"What I claim as my invention, is, 1st, giving to the platen a rotating, reciprocating motion, which enables it to assume the two positions of receiving the sheet and the impression alternately, when operated by the cam, sectional arm, and its own segment, geared with the segment of the sectional arm, by giving to it the movement described of an arc of the circle, when traversing from one of these positions to the other.

"2d, I claim affixing the vibrating bed on its own axis, so that it may recede into the proper position for receiving the inking rollers for inking the form, and become perpendicular, and directly face to face with the platen, when the toggle is straight, for the purpose of giving the impression.

"3d, I claim the arrangement of two side arms, so combined as to form a frame to hold and carry the inking rollers, and giving to them the motion, both forward and backward, over the form, for each impression, during the rest of the other parts; whether the same be done in this precise manner or equivalents to produce a like result.

"4th, I claim the grooved cam shaped arms or guides, or their equivalents, for the purpose of carrying the frisket in the right direction, and holding it in the desired position, during the intervals of rest given to the platen, that is, opening it to relieve the printed sheet, and holding it open to lay the succeeding sheet, and closing it firmly against the platen, to grip the sheet, and holding it closed until the bed has moved forward, given the impression, and receded to its original position.

"5th, I claim the combination of the bed, vibrating on its own axis, with the roller frame composed of two arms, substantially as herein described and set forth."

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19. For an *Improved Spring Bolt;* Oliver H. Bush, Fall River, Massachusetts, August 5.

Claim.—"What I claim as my improvement, is the combination of the lever with the spring bolt and its case, so as to operate therewith, substantially in the manner as specified."

On Steam Boilers and the Causes of their Explosion. *By* W. FAIRBAIRN, ESQ., C. E., F. R. S., &c.*

Continued from page 138.

1*st. Boiler Explosions arising from accumulated internal pressure.*—In nine cases out of ten a continuous increasing pressure of steam without the means of escape is probably the immediate cause of explosion; in some instances it arises from deficiency of water, but accidents of this kind are comparatively few in number, as we often find in tracing the causes that they have their origin in undue pressure, emanating from progressive accumulation of steam of great force and intensity. Let us take an example—to some of which I am able to refer—and we shall find that a boiler under the influence of a furnace in active combustion (as the recipient of heat) will generate an immense quantity of steam, and unless this is carried off by the safety valve or the usual channels when generated, the greatest danger may be apprehended by the continuous increase of pressure that is taking place within the boiler. Suppose that from some cause the steam thus accumulated does not escape with the same rapidity with which it is generated, that the safety valves are either inadequate to the full discharge of the surplus steam, or that they are entirely inoperative, which is sometimes the case, and we have at once the clue to the injurious consequences which, as a matter of fact, are sure to follow. The event may be procrastinated, and repeated trials of the antagonist forces from within, and the resistance of the plates from without, may occur without any apparent danger, but these experiments often repeated will at length injure the resisting powers of the material, and the ultimatum will be the arrival of the fatal moment when the balance of the two forces are destroyed and explosion ensues. How very often do we find this to be the true cause of accidents arising from extreme internal pressure, and how very easily these accidents might be avoided by the attachment of proper safety valves, to allow the steam to escape and relieve the boiler of those severe trials which ultimately lead to destruction. If a boiler, whose generative power be equal to 100, be worked at a pressure of 10 lbs. on the square inch, the area of the safety valves should also be equal to 100, in order to prevent a continuous increase of pressure; or in case of the adhesion of any of the valves, it is desirable that their areas should, collectively, be equal to 100. If two or more valves are used, 100 or 120 would then be the measure of outlet. Under these precautions, and a boiler so constructed, the risk of accident is greatly diminished; and provided one of the valves is kept in working order, beyond the reach of interference by the engineer, *or any other person*, we may venture to assume that the means of escape are at hand, irrespective of the temporary stoppage of the usual channels for carrying off the steam. So many accidents have occurred from this cause—the defective state of the safety valves—that I must request attention whilst I enumerate a few of the most prominent cases that have come before me. In the year 1845 a tremendous explosion took place at a cotton mill in Bolton. The boilers, three in number, were situated under the mill, and from unequal capacity in the safety valves, and even those imperfect, as they were probably fast, a terrific explosion of the weakest boiler took place, which tore up the plates along the bottom, and the steam having no outlet at the top, not only burst out the end next the furnace, demolishing the building in that direction, but tearing up the top on the opposite side, the boiler was projected upwards in an oblique direction, carrying the floors, walls, and every other obstruction before it; ultimately it lodged itself across the railway at some distance from the building. Looking at the disastrous consequences of this accident, and the number of persons—from 16 to 18—who lost their lives on the occasion, it became a subject of deep interest to the community that a close investigation should immediately be instituted, and a recommendation followed that every precaution should be used in the construction as well as the management of boilers.

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* From the London Artizan, for June, 1851.

The next fatal occurrence on record in this district was a boiler at Ashton-under-Lyne, which exploded under similar circumstances, namely, from excessive interior pressure, when four or five lives were lost; and again at Hyde, where a similar accident occurrred from the same cause, which was afterwards traced to the insane act of the stoker or engineer, who prevented all means for the steam to escape by tying down the safety valve.

There was a boiler exploded at Malaga, in Spain, some years since, and my reason for noticing it in this place is to show that explosion may be apprehended from other causes than those enumerated in the divisions of this inquiry, and that is, *incrustation*. Dr., Ritterbrandt says—in a paper read before the institution of Civil Engineers, by an eminent chemist, Mr. West—"that a sudden evolution of steam under circumstances of incrustation is no uncommon occurrence:" in several instances I have known this to be the case, particularly in marine boilers, where the incrustation from salt water becomes a serious grievance, either as regards the duration of the boiler, or the economy of fuel.

If it were supposed, as Dr. Ritterbrandt observes, that the boiler was incrusted to the extent of half an inch, it would at once be seen that nothing was more easy than to heat the boiler strongly, even to red heat, without the immediate contact of water. Under these circumstances, the hardened deposits being firmly attached to the plates, and forming an imperfect conductor of heat, would greatly increase the temperature of the iron, and the great difference of temperature thus induced between the material—and the greater expansibility of the iron—would cause the incrustation to separate from the plates, and the water rushing in between them would generate a considerable charge of highly elastic steam, and thus endanger the security of the boiler.

These phenomena were singularly exemplified in the Malaga explosion, which is thus described by Mr. Hick:—"I have ascertained that a very thick incrustation of salt was found on the lower part of the boiler, immediately over the fire, and so far as it extended the plates appear to have been red hot, thereby much weakened, and hence the explosion. The ordinary working pressure of the boiler is 130 lbs. per square inch, and perhaps at the time of the explosion very much above that pressure, as there was only one small safety valve of two and a half inches diameter. The boiler was only two feet six inches diameter, and twenty feet long."

Incrustation, exclusive of being dangerous, is attended with great expense and injury to the boiler by its removal. In the case of the Transatlantic, Oriental, or other long sea-going vessels—even after the use of brine pumps, blowing out, &c.,—a very large amount of incrustation is formed, and considerable sums of money are expended each voyage to remove it.

Other explosions of a more recent date are those which occurred at Bradford and Halifax. They are still fresh in the recollection of the public mind, and are so well known as not to require notice in this place.

I cannot, however, leave this part of the subject without reverting to an accident which occurred on the Lancashire and Yorkshire Railway, which had its origin in the same cause—excessive internal pressure. This accident is the more peculiar, as it led to a long mathematical disquisition as to the nature of the forces which produced results at once curious and interesting. The conclusions which I arrived at, although *practically right*, *were*, *however*, *considered by some mathematically wrong*, as they were firmly combated by several eminent mathematicians; and notwithstanding the number of algebraic formulas, and the learned discussions of my friends on that occasion, I have been unable to change the opinion I then formed of others more conclusive.

The accident here alluded to, occurred to the "Irk" locomotive engine, which in February, 1845, blew up and killed the driver, stoker, and another person who was standing near the spot at the time. A great difference of opinion as to the cause of this accident was prevalent in the minds of those who witnessed the explosion, some attributing it to a crack in the copper fire-box, and others to the weakness of the stays over the top —neither of these opinions were, however, correct, as it was afterwards demonstrated that the material was not only entirely free from cracks and flaws, but the stays were proved sufficient to resist a pressure of 150 to 200 lbs. on the square inch. The true cause was afterward ascertained to arise from the fastening down of the safety valve of the engine (an active fire being in operation under the boiler at the time) which was under the shed, with the steam up, ready to start with the early morning train.

The effect of this was the forcing down of the top of the copper fire box upon the blazing embers of the furnace, which, acting upon the principle of the rocket, elevated the boiler and engine of 20 tons weight to a height of 30 feet, which, in its ascent, made a summerset in the air, passed through the roof of the shed, and ultimately landed at a distance of 60 yards from its original position. The question which excited most interest, was the absolute force required to fracture the fire-box, its peculiar properties, when once liberated, and the elastic or continuous powers in operation, which forced the engine from its place to an elevation of 30 feet from the position on which it stood. An elaborate mathematical discussion ensued relative to the nature of these forces, wich ended in the opinion that a pressure sufficient to rupture the fire-box, was by its continuous action, sufficient to elevate the boiler and produce the results which followed. Another reason was assigned, namely, that an accumulated force of elastic vapor, at a high temperature, with no outlet through the valves, having suddenly burst upon the glowing embers of the furnace, would charge the products of combustion with their equivalents of oxygen, and hence explosion followed. Whether one or both of these two causes were in operation is probably difficult to determine; at all events, we have in many instances precisely the same results produced from similar causes, and unless greater precaution is used in the prevention of excessive pressure, we may naturally expect a repetition of the same fatal results.

The preventives against accidents of this kind are well constructed boilers of the strongest form, and duly proportioned safety valves,—one under the immediate control of the engineer, and the other, as a reserve, under the keeping of some competent authority.

2*d. Explosions from deficiency of water.*

This division of the subject requires the utmost care and attention, as the circumstance of boilers being short of water is no unusual occurrence. Imminent danger frequently arises from this cause, and it cannot be too forcibly impressed upon the minds of engineers, that there is no part of the apparatus which constitutes the mountings of a boiler which requires greater attention—probably the safety valves not excepted—than that which supplies it with water. A well constructed pump, and self acting feeders—when boilers are worked at a low pressure—are indispensable, and where the latter cannot be applied, the glass tubular gauge steam and water cocks must have more than ordinary attention.

In a properly constructed boiler, every part of the metal exposed to the direct action of the fire should be in immediate contact with the water, and when proper provision is made to maintain the water at a uniform height and depth above the plates, accidents can never occur from this cause.

Should the water, however, get low from defects in the pump, or any stoppage of the regulating feed valves, and the plates over the furnace become red hot, we then risk the bursting of the boiler, even at the ordinary working pressure. We have no occasion, under such circumstances, to search for another cause, from the fact that the material when raised to a red heat has lost about five-sixths of its strength, and a force of less than one-sixth will be found amply sufficient to bear down the plates direct upon the fire, or to burst the boiler.

When a boiler becomes short of water, the first and perhaps the most natural action is to run to the feed valve, and pull it wide open. This certainly remedies the deficiency, but increases the danger, by suddenly pouring upon the incandescent plates a large body of water, which coming in contact with a reservoir of intense heat is calculated to produce highly elastic steam. This has been hitherto controverted by several eminent chemists and philosophers, but I make no doubt such is the case, unless the pressure has forced the plates into a concave shape, which for a time would retard the evaporization of the water when suddenly thrown upon them. Some curious experimental facts have been elicited on this subject, and those of M. Boutigney, and Professor Bowman, of King's College, London, show that a small quantity of water projected upon a hot plate does not touch it; that it forms itself into a globule surrounded with a thin film, and rolls about upon the plate without the least appearance of evaporation. A repulsive action takes place, and these phenomena are explained upon the supposition that the spheroid has a perfectly reflecting surface, and consequently the heat of the incandescent plate is reflected back upon it. What is, however, the most extraordinary in these experiments is, the fact that the globule, whilst rolling upon a red hot plate, never exceeds a temperature of about 204 degrees of Fahrenheit; and in order to produce ebullition, it is necessary to cool the plate until the water begins to boil, when it is rapidly dissipated in steam.

The experiments by the committee of the Franklin Institute, on this subject, give some interesting and useful results. That committee found that the temperature of clean iron, at which it vaporized drops of water, was 334° Fahrenheit. The development of a repulsive force, which I have endeavored to describe, was however so rapid above that temperature, that drops which required but one second of time to disappear at the temperature of maximum vaporization, required 152 seconds when the metal was heated to 395° of Fahrenheit. The committee goes on to state that—"One ounce of water introduced into an iron bowl three-sixteenths of an inch thick, and supplied with heat by an oil-bath at the temperature of 346°, was vaporized in fifteen seconds, while at the initial temperature of 307°, that of the most rapid evaporization was thirteen seconds."

The cooling effect of the metal is here strikingly exemplified, by the increased rapidity of the evaporization, which at a reduced temperature of 38° is effected in thirteen instead of fifteen seconds.

This does not, however, hold good in every case, as an increased quantity of water, say from one-eighth of an ounce to two ounces, thrown upon heated plates, raised the temperature of its evaporation from 460° to 600° Fahrenheit: thus clearly showing that the time required for the generation of explosive steam under these circumstances is attended with danger, and it may be doubted whether the ordinary safety valves may not be wholly inadequate for its escape.

Numerous examples may be quoted to show that explosions from deficiency of water, although less frequent than those arising from undue pressure, are by no means uncommon—they are, nevertheless, comparatively fewer in number, and the preventives are good pumps, self-acting feeders (when they can be applied), and all those conveniences, such as water cocks, water gauges, floats, alarms, and other indicators of the loss and reduction of water in the boiler.

3*d*. *Explosions produced from collapse.*

Accidents from this cause can scarcely be called explosions, as they arise, not from internal force, which bursts the boiler, but from the sudden action of a vacuum within it. In high-pressure boilers, from their superior strength and circular form, these accidents seldom occur, and the low-pressure boiler is effectually guarded against it by a valve which opens inwards by the pressure of the atmosphere whenever a vacuum occurs. In some cases a collapse of the internal flues of boilers has been known to take place, from a partial vacuum within, which, united to the pressure of the steam, has forced down the top and sides of the flue, and with fatal effect discharged the contents of the boiler into the ash-pit, and destroyed and scalded everything before it. A circumstance of this kind occurred on the Thames on board the steamer *Victoria*, some years since, when a number of persons lost their lives, and serious injury was sustained in all parts of the vessel within its reach. This accident could not, however, be called an explosion, but a collapse of the internal flues, which were of large dimensions, and the consequent discharge of large quantities of steam and water into the space occupied by the engines.

One or two cases which bear more directly on this point are, however, on record, and one of them, which took place in the Mold mines, in Flintshire, was attended with explosion. The particulars, as given by Mr. John Taylor, will be found circumstantially recorded in the first volume of the *Philosophical Magazine*. This occurrence seems to prove that rarefication produced in the flues of a high-pressure boiler may determine an explosion. The boiler which exploded belonged to a set of three feeding the same engine; the fuel used was bituminous coal. The furnace doors of all three of the boilers had been opened, and the dampers of two had been closed, when a gust of flame was seen to issue from the mouth of the furnace of these latter, and was immediately followed by an explosion. The interior flue of this boiler was flattened from the sides, the flue and shell of the boiler remaining in their places, and the safety valve upon the latter not being injured.

Other similar cases of collapse might be stated, but as most of them have been attended by a defective supply of water in the boiler, the plates over the fire having become heated, they can scarcely be included in the category of this class of accidents, and more properly belong to those of which we have just treated,—explosions from a deficiency of water in the boiler.

It is nevertheless necessary to observe that cases of collapse should be carefully guarded against, as the great source of danger is in the escape of hot water, which, with the steam generated by it, produces death in one of its worst and most painful forms.

The remedies for these accidents will be found in the vacuum valve, and careful construction in the form and strength of the flues.

4th. Explosions from defective construction.

This is, perhaps, one of the most important divisions that can possibly engage our attention, and on which it shall be my duty to enlarge. In a previous inquiry, I have already shown the nature of the strain and the ultimate resistance which the material used in the construction of boilers is able to bear. We have not, however, in all cases, shown the distribution and position in which that material should be placed in order to attain the maximum of strength, and afford to the public greater security in the resisting powers of vessels subject to so severe and sometimes ruinous pressure. This is a subject of such importance that I shall be under the necessity of trespassing upon your time, in endeavoring to point out the advantages peculiar to form, and the use of a sound and perfect system of construction.

For a number of years, the haycock, hemispherical, and wagon-shaped boilers were those generally in use, and it was not until high pressure steam was first introduced into Cornwall, that the cylindrical form with hemispherical ends, and the furnace under the boiler, came into use; subsequently, this gave way to the introduction of a large internal flue extending the whole length of the boiler, and in this the furnace was placed. For many years this was the best and most economical boiler in Cornwall, and its introduction into this country has effected great improvements in the economy of fuel as well as the strength of the boiler. Several attempts have been made to improve this boiler by cutting away one half of the end, in order to admit a larger furnace. This was first done by the Butterley Company, and it has since gone by the name of the Butterley boiler. This construction has the same defects as the haycock or *hemispherical* and wagon-shaped boilers; it is weak over the fire place, and cannot well be strengthened without injury to the other parts of the boiler, from the vast number of stays necessary to suspend the part which forms the canopy of the furnace. Of late years a much greater improvement has, however, been effected by the double flue and double furnace boiler, which is now in general use, and has nearly superseded all the other constructions. It consists of the cylindrical form, varying from five to seven feet in diameter, with two flues, which extend the whole length of the boiler; they are perfectly cylindrical, and of sufficient magnitude to admit a furnace in each. This boiler is the simplest and probably the most effective that has yet been constructed. It presents a large flue surface as the recipient of heat, and the double flues when riveted to the flat ends add greatly to the security and strength of those parts. It moreover admits of the new process of alternate firing, so highly conducive to perfect combustion, and the prevention of the nuisance of smoke.

5th. Explosions arising from mismanagement or ignorance.

To mismanagement, ignorance, and the misapplication of a few leading principles in connexion with the use and application of steam, may be traced the great majority of accidents which from time to time occur. Many of these accidents, so fruitful of the destruction of property and human life, might be prevented, if we had well constructed vessels judiciously united to skill and competency in the management. To convey a few practical instructions to engineers, stokers, and engine men, would be an undertaking of no great difficulty. A young man of ordinary capacity would learn all that is necessary in a few months: and if placed under competent instructors, he might be made acquainted with the properties of steam, its elastic force at different degrees of pressure, the advantages peculiar to sensitive and easy-working safety-valves, the necessity for cleanliness and keeping them in good working condition; the use of water gauges, fusion plugs, indicators, signals, &c., &c., connected with the supply and height of water in the boiler. The dangers to be apprehended from a scarcity of water, the danger of explosion when the engine is standing, or when the usual channels for relieving the boiler of its surplus steam are stopped,—all these are parts of elementary instruction which the stoker, as well as the engineer, should be acquainted with, and no proprietor of a mill, captain of a steamship, or superintendant of locomotive, should give employment to any person unless they can produce certificates of good behaviour, and a knowledge of the elementary principles of their profession.

If these precautions were adopted, greater care observed in the selection of men of skill and responsibility in the construction of boilers, and a more strict and rigid code of laws in the management, we may look forward with greater certainty to a considerable diminution, if not a prevention, of those calamitous events which so frequently plunge whole families into mourning by unexpected and instantaneous death.

As an individual I would cheerfully lend my best assistance to the development of a principle of instruction, calculated to relieve the country of the ignorance which pervades that part of the community on which the lives of so many depend. A resolution on the part of those who employ persons of this description, and whose interests are so much at stake, to take none whose knowledge and character does not come up to the requisite standard, *and pay for it*, would soon find, from the economy of the management, and the increased security of their property, a very important change in all the requirements of the economy, as well as the application of steam. How often do we find implements of danger, and vessels containing the elements of destruction, in the hands of the most ignorant and reckless practitioners, whose insensibility to danger, and total incompetency to judge of its presence, renders them above all others the most unfit to be employed. And why? because they are the very persons, from their defective knowledge, to increase the danger and aggravate the evils they were selected to prevent. It is not the first time that engineers, to secure (if I may use the expression) an insane pressure, have fastened the safety valves, and screwed down the steam valve, closing every outlet, without ever thinking of the fire that was blazing under the boiler.

Under such circumstances what could be expected but a blow up? A madman rushing with a lighted match into a powder magazine could not act with greater insanity: such, however, has been the case, and that arising from want of thought, or what is worse, from the total absence of knowledge which it was the duty of his employer as well as himself to have possessed.

I have on former occasions, stated that I am not an advocate for legislative interference either in the construction or management of boilers, but seeing the dangerous tendency of these vessels when placed under the control of ignorance and incapacity, I would forego many considerations to encourage a more judicious and intelligent class of men than has hitherto been employed in the care and management of steam and the steam engine. The reforms necessary to be introduced may be done by the owners of steam engines, steam boats, railways, and others engaged in the use and application of this important element. A desire to enforce more judicious and stringent regulations, to remunerate talent, and to employ only those whose good conduct and superior knowledge entitled them to confidence, is the only sure guarantee of public safety and the prosperity of the employer.

Lastly. *The remedies applicable for the prevention of accidents arising from explosion.*

Having noticed in the foregoing remarks most of the causes incident to boiler explosions, it now only remains to draw such inferences as will point out the circumstances which it is desirable to cultivate, and others which it is desirable to avoid. These circumstances I have endeavored to class in such way as to bring the subject prominently forward, and to point out under each head, first, the causes which lead to accident; and secondly, the means necessary to be observed in avoiding it. In a general summary it may not be inexpedient briefly to recapitulate these statements, in order to impress more forcibly upon the mind of those concerned the necessity for care and consideration in the use of one of the most powerful agents ever placed at our disposal.

One of the most scientific nations of Europe places the greatest confidence, as a means of safety , on the use of a fusible metal plate over the furnace. These plates are alloys of tin and lead with a small portion of bismuth, in such proportions as will ensure fusion at a temperature something below that of molten lead. In France, the greatest importance is attached to these alloys, and in order to ensure certainty as to the definite proportions, the plates are prepared at the royal mint, where they may be purchased duly prepared for use. In this country these alloys are not generally in use, but in this respect I think we are wrong, as boiler explosions are not so frequent in France as in this country, and high-pressure steam, from it's superior economy, is more extensively used in France than in England. In my own practice I invariably insert a lead rivet one inch in diameter immediately over the fire place, and as lead melts at 640 degrees, I have invariably found these metallic plugs a great security in the event of a scarcity of water in the boiler. I am persuaded many dangerous explosions may be avoided by the use of this simple and effective precaution, and as pure lead melts at 600 degrees, we may infer from this circumstance that notice will be given and relief obtained before the internal pressure of the steam exceeds that of the resisting powers of the heated plates. As this simple precaution is so easily accomplished, I would advise its general adoption. It can do no harm to the boiler, and may be the means of averting explosions and the destruction of many valuable lives.

The fusible metal plates as used in France are generally covered by a perforated metallic disc, which protects the alloy of which the plate is composed, and allows it to ooze through as soon as the steam has attained the temperature necessary to insure the fusion of the plate. The nature of the alloy is, however, somewhat curious, as the different equivalents have different degrees of fluidity, and the portion which is the first to melt is forced out by the pressure of the steam, leaving the adhesion of the less fusible parts in a most imperfect state, incapable of resisting the internal force of the steam. The result of these compounds is, the fusion of one portion of the alloy and the fracture of the other, which is generally burst by pressure.

This latter description of fusible plates is different to the lead plug over the fire, as the one is fused at 600 degrees by the heat of the furnace, and the other, by the temperature of the steam, raised to the fusible point of the alloy, which varies from 280 to 350 degrees.

Another method is the bursting plate, fixed in a frame and attached to some convenient part of the upper side of the boiler; this plate to be of such thickness and of such ductility as to cause rupture whenever the pressure exceeds that of the weight on the safety-valve. There can be no doubt that such an apparatus, if made with a sufficiently large opening, would relieve the boiler; but the objection to this and several other devices is the frequent bursting of those plates, and the effect every change of pressure has upon the material in reducing its powers of resistance, and thus increasing uncertainty as to the amount of pressure in the boiler, as well as the constant renewal of the plates.

It has already been noticed that one of the most important securities against explosions is a duly proportioned boiler, well constructed, and to this must be added ample means for the escape of the steam on every occasion when the usual channels have been suddenly stopped. The only legitimate outlets under these circumstances appear to me to be the safety valves, which, connected with this inquiry, are indispensable to security. Every boiler should, therefore, have two safety-valves, of sufficient capacity to carry off the quantity of steam generated by the boiler. One of these valves should be of the common construction, and the other beyond the reach of the engineer or any other person.

Defective construction is unquestionably one of the greatest sources of the frightful accidents which we are so frequently called upon to witness. No man should be allowed unlimited exercise of judgment in a question of such vital importance as the construction of a boiler, unless duly qualified by matured experience in the theoretical and practical knowledge of form, strength of materials, and other requirements requisite to insure the maximum of sound construction. It appears to me equally important that we should have the same proofs and acknowledged system of operations in the construction of boilers, as we have in the strength and proportions of ordnance. In both cases we have to deal with a powerful and dangerous element, and I have yet to learn why the same security should not be given to the general public as we find so liberally extended to an important branch of the public service. In the ordnance department at Woolwich (with which I have been more or less connected for many years) the utmost care and precision is observed in the manufacture of guns, and the proofs are so carefully made under the superintendance of competent officers as to render every gun an engine of perfect safety to the extent of 1000 to 1200 rounds of shot.

For the Journal of the Franklin Institute.

Arrival of the Screw Steamer "City of Manchester."

This fine screw steamer has recently arrived at our city, after a passage of 18 days from Liverpool to the Capes, having a full freight list and a large number of passengers, thus proving that freight and passengers may be obtained in sufficient quantities for this Port, when suitable vessels are provided for the trade. This vessel is the second of the line, the City of Glasgow being the first; the third vessel, the City of Pittsburg, is nearly completed in New York, and will be put on the line this fall. The fourth vessel is yet to be built, and it is to be hoped that an enterprise that has obtained a large amount of its support from this city, may be able to diffuse a portion of its money among our mechanics, who are, at least, entitled to the courtesy of a trial when they are willing to *guarantee* as good a result as has been obtained by any screw steamer of the same class. The City of Manchester is of iron, 274 feet long on deck, 37 feet 9 inches beam, 31 feet hold, burthen 1900 tons Custom House measurement, being the largest iron steamer yet built, (the Great Britain excepted.) She has four masts, two of them only with yards, but the other two carry very large gaff topsails, so that, when necessary, she can spread a very large amount of canvass. The propelling power consists of two vertical beam engines placed across the ship. Diameter of cylinders 73 inches, and stroke 5 feet. The beams consist each of two plates of wrought iron, supported on cast iron columns, which rise from, and are securely attached to, the bed plate of the engine. On the crank shaft of the two engines (which are connected together at right angles) is a large spur wheel 9½ feet diameter, and 4½ feet face, having wooden teeth, which gear into a pinion of 4¾ feet diameter on the propeller shaft, so that each revolution of the engines, produces 2 revolutions of the propeller, which is 14 feet diameter, and 19 feet pitch; on her trial trip to Belfast, her engines made an average of 25 revolutions, and her reported speed was 11 knots per hour. As a fine specimen of iron ship building, she is well worthy of the examination of our mechanics, the more so as this is the iron emporium of the United States, and sooner or later, iron steamers will have to be built. Even at the present moment, they are the cheapest when every thing is taken into consideration, but it would be hard to convince our merchants of the fact, unless they would take the matter fully in hand, and examine it in all its bearings. To such as are disposed to look fairly at the subject, I risk nothing in stating that I could soon convince them that *iron* was (all things considered) the cheapest material for ship building. B.

For the Journal of the Franklin Institute.

A Series of Lectures on the Telegraph, delivered before the Franklin Institute. Session, 1850–51. *By* Dr. L. Turnbull.

Continued from page 128.

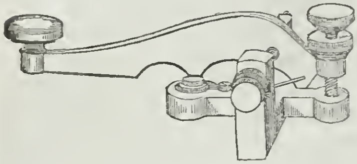
The device of the local circuit in the Morse Telegraph was founded in part upon the experiments of Prof. Henry, who had previous to this, "opened the circuit of a large quantity magnet at Princeton, when loaded with several hundred pounds, by attracting upwards a small piece of movable wire, by means of a small intensity magnet, connected with a long wire circuit and an intensity battery."

The re-issued patent of January 15th, 1846, and the patent of 11th of April, 1846, were both re-issued on the 13th of June 1848, and another patent containing improvements in the electric Telegraph was taken out on the 1st of May, 1849.

The line between Baltimore and Washington, is the only one constructed under governmental patronage, the remainder having been projected by private enterprise; the patentee being allowed one half the stock for the use of the patent, as his share of the investment; the capital invested in them up to January 1st, 1850, was nearly $400,000, exclusive of the patent right, upon which Prof. Morse up to that time had received some $30,000. The machine at present in use, consists of three main portions, the transmitting and receiving apparatuses with the connecting circuit.

The spring lever key as at present used in the Morse Office, was suggested by Mr. Thomas C. Avery, of New York, but has received various modifications; in Fig. 24, we have a view of its present improved form: it consists of a nicely balanced lever, supported on standards raised from a small block of mahogany; thumb screws are fixed to each extremity of it, that on the longer arm being used for the operator to play upon, and the shorter one to adjust the distance of the connecting surfaces; on the short arm is attached a spring to keep those surfaces apart when not pressed together by the operator; the connecting surfaces called the hammer and the anvil, the former on the lower surface of the long arm of the lever, the latter on the mahogany support, are faced with platinum; they are respectively connected with the opposite poles of the galvanic circuit, and by their contact or separation, the circuit is united or broken.

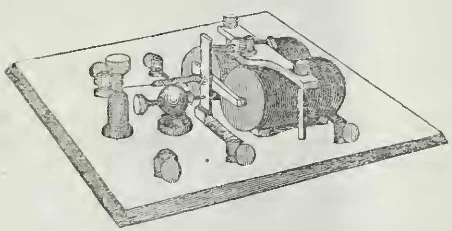
Fig. 24.



If this key is at an intermediate station, by means of the screw on the short arm the surfaces are kept together; the circuit may be closed when not in use; this permits communications to be sent through the office between stations on each side of it, or rather it keeps the main circuit continuous; when operating, if they are merely touched, a point is made at the receiving station, if kept together any time a line is produced whose length is governed by the period of contact; the circuit connexions are beneath, one below the anvil, the other under the screw.

The receiving magnet is an intensity one, surrounded by a helix of very fine wire, 3000 feet or more in length, having the horse shoe form, and fixed in a horizontal position. The main circuit passes through this helix unbroken to the next station; an armature is fixed to a vertical movable standard, opposite the poles of this magnet, in such a manner, that by means of a spring and adjusting screws, it cannot come in actual contact with the magnet, nor yet is it so far removed as to be beyond its influence; the object of this delicate suspension, is that the armature may be approached to or withdrawn from the magnet's influence according to the intensity of the current; much of the operator's skill depends on the management of this adjuster, as the varying electrical agencies of the atmosphere and generating forces of the batteries are constantly operating to increase or diminish its intensity.

Fig. 25.



The support of this armature forms part of the local circuit, the horizontal rod above another part, and the circuit is closed, by the attraction of this armature to the poles of the magnet, through the horizontal rod above, terminating in a platinum face, opposite another one fixed on the horizontal support above the magnet; the connexions of the local circuit are through screws seen on the right; when the current flows through the main circuit the receiving magnet attracts the armature, and thus closes the local circuit, the only place where it is open being above the horizontal bar over the helix: the local circuit is confined entirely to the office where it belongs, passing through the local battery and the helix of the register magnet, being distinct from the main; the registering apparatus has or should have, a quantity magnet of a horse shoe form, fixed vertically, the open extremity upward; the object being to indent impressions upon paper; force, rather than delicacy, is requisite. The figure from Davis' Manual of Magnetism, represents the mechanical action of the instrument; above the poles of the magnet, is an armature attached to one end of a movable lever, which has on the upper surface of the other end, a metal point which fits into a groove of a roller above it; the passage of the galvanic current making the magnet attract and depress the armature, raises the points at the other extremity, and makes an impression on the paper in dots or lines, according to the duration of the current; a spring is used here to withdraw the armature from the magnet after the cessation of the current, which must be so arranged, as not to carry the armature too far from the magnet, or let the points too deep into the groove; a lead pencil was first used, afterwards a pen with an ink reservoir, which was laid aside for the hard steel points; the impressions on the paper resemble the raised printing for the blind; the connexion with the local battery is made through the screw caps on the right hand.

Fig. 26.

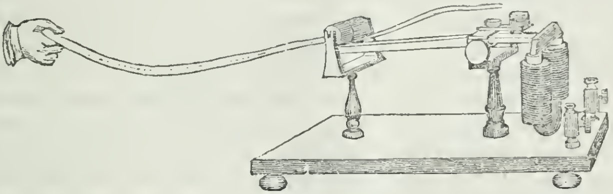
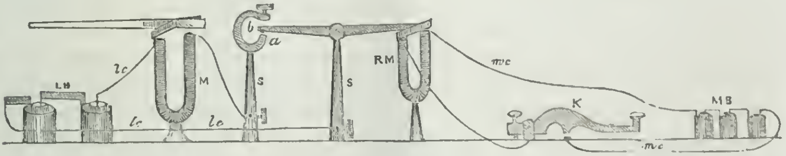


Fig. 27.



"Fig. 27 represents the arrangement and relations of the magnets, batteries, and circuits: R M representing the small magnet, *m c* the main circuit of indefinite extent, M B the distant battery, K the key which breaks and closes this extended circuit; *l c* and L B represent the local circuit and battery, M the helices of the register magnet included in the circuit, which, as the standards, S S, are metallic, is broken only at the points *a b*. Now, the least possible space between these points effectually interrupts the current, and as they are covered with platinum, a very slight contact is sufficient to establish the connexion. The little instrument is so delicately adjustable, that often, when the breath would stop the vibrations of the lever, the circuit is broken and closed with certainty and regularity; this is also shown on a larger scale in fig. 28."

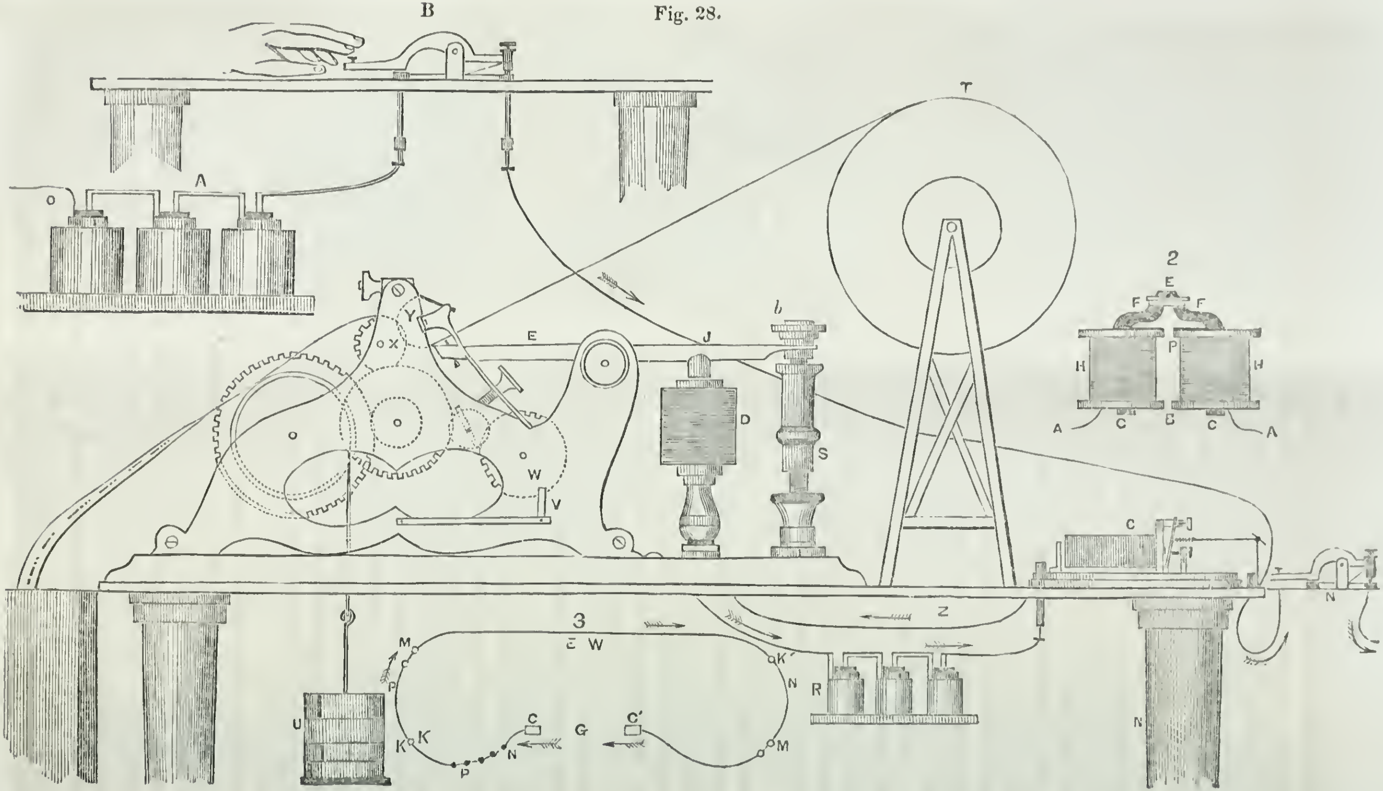
Many forms of this instrument have been devised, some with the levers vertical; in others, the magnet was attached at one end, and the style at the other end of a shaft working through a horizontal tube.

The figure (28) slightly amended, from one in the *Phrenological Journal*, March, 1851, represents the whole combination of the registering apparatus and its connexions with the main and local circuits, together with the distant and local operating keys. The register occupies the centre of the picture, being supported on two standards: T is a spool carrying a roll of paper; this paper is prepared by manufacturers for this especial use, by winding it into large rolls, and dividing it into smaller rolls of one inch or more in width by a knife, while it is revolving in a lathe; from this spool the paper is drawn between the two rollers x and y, which are turned by means of the weight U, moving the clock work above it; D is the register magnet, E the lever, having the armature at L, and its axis or fulcrum to the left of it, also at the extreme left, the style playing in a groove of the lower surface of the wheel y; S on the right, is a screw to limit the motion of the style, a distance of one-eighth of an inch being usually allowed; it also contains a spiral spring below, to separate the armature and magnet; the paper is dealt off steadily from the spool, and a momentum is prevented by springs fixed on the axis of the spool between the latter and its standards; formerly a break was suspended from the lower surface of the lever upon some of the clock wheels below, to permit and arrest their motion, but this is now supplied by the small jack V setting into the cogs of the wheel W, the swiftest one in the train; this the operator pushes down immediately on the reception of a signal and the weight U sets the whole in motion, drawing the paper off the spool between the rollers x and y, the style impressing on it the required characters, and it rolls finally into the vessel on the left, ready to be read at the convenience of the receiver.

In the earlier forms an alarm was appended to call the attendant's attention, but this is thrown aside, as the click of the register answers the purpose; some experienced operators become so accustomed to this click that they can declare the message without referring to the character made by the style; thus it becomes phonetic, and operators conversing at vast distances, can make the little instrument by its varied action, slow, rapid, or impetuous, give expression to the different feelings of the mind; each office has its own peculiar signal, known to all the rest on the line, and an answer is expected as soon as it is given.

The machine is wound up by a key fixed to the axis of the largest wheel on the left; some guides are used to conduct the paper beneath the style with such regularity that several communications may be printed parallel to each other on the same strip.

Fig. 28.



The peculiar form of magnet used in the registering department, is seen in the diagram No. 2, to the right of the register. A, A, the circuit connexions; C C, lower extremities of the soft iron bars, which are joined together; H H, reels of the helices around the iron; F F, the upper ends of the soft iron, having opposite polarities; P, the point of connexion between the wires of the two helices; E, the armature; B, above represents the operating key of a distant office, situated on the main line, with the attendant in the act of transmitting a communication; O, the main line coming from the distance; A, the battery on that line; Groves' battery is mostly in use, 30 cups of which are necessary in a space of 150 miles; they may be kept in one body, but it is better to distribute them at intervals along the line; they require cleansing and replenishing about once a fortnight. After passing through the key, the main circuit follows the course of the arrow to the receiving magnet C on the right, traverses the helix of that, and issues again from it, continuing its course to the right, to the next station, and so it might go on indefinitely, or around the world; N, is the local operating key through which the line passes in the same manner as at B; this is the entire relation of the main circuit to an office; it makes the receiving magnet close the local circuit, and it will do it not only at one station, but at all on the same line, and at the same time; so that an operator in Philadelphia, can transmit his message to St. Louis, and drop it at all the intermediate stations at one and the same moment; this has actually been performed.

Only one wire is now used on the main line, the earth affording the return circuit; No. 3, shows it very well; one end of the line may be supposed at Philadelphia, the other at New York; M M, receiving magnets of the two stations; K K, the operating keys respectively, P and N, the positive and negative poles of a battery on the line: C C, plates where the wires terminate in the ground: the connexion of the wires to a gas pipe, will answer every purpose; the arrows represent the direction of the current; G, that portion of the ground forming the circuit. By having two wires, one connected respectively to the keys and magnets of the different offices, communications may be sent both ways at the same time, but only one current can traverse the same line at once.

The local circuit Z is short, simple, and effective, being closed by the receiving magnet; C the current starts from the local battery R, consisting usually of from two to three cups, that must be cleansed every morning for efficient operation, runs through the helix D, back to the receiving magnet in the course of the arrow to the local battery; this causes the style to raise and make an impression on the paper; the whole operation then is very simple; the key depressed at a distant city or station, B causes the receiving magnet C, at Philadelphia, to close the local circuit: the iron of the helix is made instantly magnetic, and the style goes against the paper, and stays there as long as the key is kept down at B. A simple contact makes a dot (·), a longer time a line (—). Considerable experience is requisite to make a good operator, either to transmit or read messages; some, however, become quite proficient after three months tuition; the interval between the times of contact, is regarded as well as the letter, for by its length, letters, words and sentences, are distinguished from each other; the adjoined table contains the Morse Telegraphic characters.

A	- —	J	— - — -	S	- - -	Numerals.		9	— - - —
B	— - - -	K	— - —	T	—	1	- — — -	0	———
C	- - -	L	——	U	- - —	2	- - — - -		
D	— - -	M	— —	V	- - - —	3	- - - — -		
E	-	N	— -	W	- ——	4	- - - - —		
F	- — -	O	- -	X	- — - -	5	— — —		
G	— — -	P	- - - - -	Y	- - — - -	6	- - - - - -		
H	- - - -	Q	- - — -	Z	- - - -	7	— — - -		
I	- -	R	- - -	&	- - - -	8	— - - - -		

If an operator at Philadelphia, wishes to send a communication to Baltimore, he first breaks the main circuit by opening the operating key at his station. All the receiving magnets in that circuit cease to attract their armatures, the spring draws them away from the magnets, and thus breaks all the short office circuits. The Philadelphia operator then makes the signal for Baltimore, by tapping on his key, the proper number of times; this produces a clicking of the registers, which is heard and understood in all the offices on the line, though none but the Baltimore operator pays any regard to it.

Then the Baltimore operator opens his transmitting or operating key, and breaks the main circuit in another place, so that the Philadelphia operator cannot operate his main circuit, which the latter discovers by the silence of his own receiving magnet when he operates his key; he then closes his key to permit the operator at Baltimore to return an answer.

The Baltimore operator closes his key, sets his clock work in motion, and returns word that his Philadelphia correspondent may send his communication, which the latter hears, and goes to work accordingly.

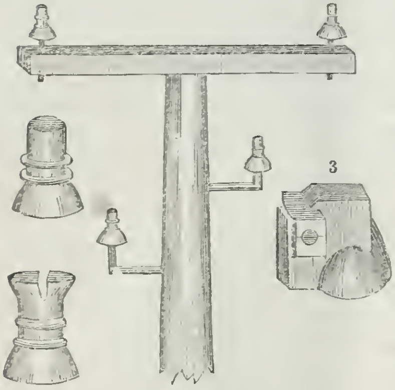
If the Philadelphia operator wishes to telegraph his message to several or all the stations on the line, he makes in succession, all the signals of those offices, and awaits their replies; after receiving them all, he commences to operate, and the communication is received by every one of them at the same moment.

The daily performance of this machine is to transmit from 8000 to 9000 letters per hour; there are a number of attendants needed about an office transacting much business, each one of whom has his respective department: they are divided into "copyists, book keepers, battery keepers, messengers, line inspectors and repairers"; the usual charge of transmission is 25 cts. for ten words sent one hundred miles; the messages vary in value from 10 cts. to $100; the amount of business which a well conducted office can perform, and the nett proceeds arising therefrom, may well excite our surprise; a single office in this country with two wires, one 500, the other 200 miles in length, after spending three hours in the transmission of public news, telegraphed in a single day, 450 private messages averaging 25 words each, besides the address, sixty of which were sent in rotation, without a word of repetition.

The public journals, however, often contain notices of errors committed by the operators on these lines, which, from their importance, have been the cause of considerable complaint among business and newsmen. This is variously attributed to careless attendants, disarrangement of the circuits, or the alphabetic combination, which renders the best receivers and copyists liable to mistake; this is not all, for instances can be cited where messages sent immediately, as the clerks promised to do, would have answered the desired end, but being delayed three hours, were utterly valueless.

Several important things are necessary to the successful operation of the instrument; skilful manipulators, good batteries and machines, and more than all, thorough insulation of the conductors; the latter can never be completely accomplished, as the best non-conductors will conduct in a slight degree. Copper wire first employed, has, on account of expense, been laid aside for iron, of which 300 lbs. are required to a mile: the method of insulation consists in winding them around glass knobs, passing them through caps of the same material, or enclosing them throughout with gutta percha.

Fig. 28.



"The figure shows the methods of attaching them to glass caps, by supporting the wire from their side (1,) or resting them in a groove on the top (2,) these caps fit over wooden or iron pins, which are fastened on the top of horizontal cross bars, or driven into the side of the post; two blocks of glass in the form of a parallelopiped, and dovetailed together in such a manner, as to let a wire, without any other fastening, slide through a central opening; the glass being surrounded and protected by wood; the most recent method consists of glass blocks, fitted in cast iron caps and supported on the peg by a heavy glass tube (3.) The caps, of whatever form, are either upon cross-bars, or supported by iron staples driven into the post."

Notwithstanding these precautions, by the contact of wires blown about by winds, moisture, &c., connexions are made through the ground or otherwise, and a short circuit is formed, instead of going the entire route of the line, or part of the current of greatly diminished intensity, pursues the latter course.

The following method of ascertaining the existence of a break, or forming connexions with different offices at will, is well described by Mr. Chas. T. Chester of New York, in Silliman's Journal, Vol. v. 2d, series. It has been found that the intermediate offices on a main line are of great utility in determining the situation of the breech.

If the circuit is broken on one side, a current is at once obtained from the battery of the unbroken side, and the accident found is repaired. The diagram shows how to apply this test, and the method of dividing the long line into sections. The black dots, A B C D, in Fig. 31, represent brass terminations of conductors, sunk on a level with the surface of the operator's table; a metallic button, fig. 30, plays over their surface. This button connects each brass stud with its opposite, and a change in its position changes the direction and channel of the current at pleasure. Thus, the intermediate operator wishes to break and close the "through circuit, (this is synonymous with main circuit,) he turns his button, bringing B in contact with D; the course of the current can be easily traced. But again, cutting off his left hand neighbor, he wishes to converse with his right, the button changed so as to connect A with C, the current passes directly to the ground through his instruments. Supposing a binding screw at S, the left or right hand wire may thus be brought in connexion with the ground. The buttons 1, 2, and 3, are simply used as convenient duplicate keys, or circuit closers, when the operator is receiving."

Fig. 30.

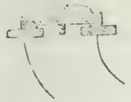
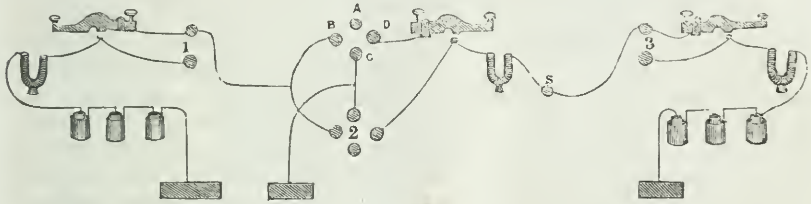


Fig. 31.



When the line is found deranged at an intermediate office, by the evidence of a current unnaturally strong or weak, the impression is that the wire is broken at one or both sides of the office. Supposing the wire continuous from one end of the line to the other, and a battery at each, the current passes through the intermediate magnet without interruption, and the circuit established is termed a "through circuit." When a derangement is perceived, the intermediate operator alters the through circuit, and by connecting with the ground, makes two short circuits.

Several methods have been devised to obviate the disastrous consequences that sometimes result from violent electrical action during thunder storms, such as the melting or breaking of wires, total destruction of long distances of the circuit, injury to office furniture or the operators connected with it; among the most important of which are those that combine the readiest communication with the ground to convey away the superabundant fluid; one is to have the circuit closer of a receiving magnet, employed for this sole purpose, pass into the earth; another is the metallic connexion with the surface of a brass ball, surrounded by a ring situated in and forming part of the circuit, from the inner circumference of which minute metallic points project towards, but do not quite touch the ball; both of these, however, are inefficient at times.

Professor Morse, has deservedly received the highest approbations of the American people for the invention that not only calls forth wonder at its accomplishments, but has proved itself an invaluable agent in political economy. Excepting efficient and economical batteries, most of the discoveries in this department of science had been made, which were essential to a proper foundation of his invention; some hand was necessary to elicit the remaining facts, combine and give them a mechanical arrangement and application, and then to thrust it before a distrustful public, to solicit the attention and patronage of the government for the proper attestation of its merits.

It was novel to the American people; no one had projected the thing here successfully, though many had thought of, and some tried it; through Professor Morse's indefatigable perseverance, the adjuvant resources of science were united in the form of utility; though dependant for most of his information upon others, he had the confidence in its final success, to master opposing obstacles, and bring to his aid, those who had labored honorably and prosperously in the progress of knowledge.

To be Continued.

For the Journal of the Franklin Institute.

On P. V. Du Trembley's Combined Vapor Engine.

At the works of Messrs Stillman & Allen, New York, there is now in operation, one of Du Trembley's combined vapor engines, which is worthy of notice from its peculiar construction; but more particularly as it is claimed by the inventor, that 50 per cent. of the fuel used in the ordinary steam engine and boiler, will in the combined engine be saved; or, in other words, a given amount of fuel will do twice the work in the combined vapor engine, that it will in the ordinary steam engine, a result most devoutly to be wished, no matter how cheap fuel may become. A description of the engine is here given in the inventor's own language:—

"This invention is applied either to a single engine, with two cylinders and pistons, or, as is usual for maritime purposes, two distinct engines, with a cylinder and piston each. In either case, one of the pistons is acted upon by steam, and the other by the vapor of perchloride, or of any other easily vaporized liquid, termed auxiliary liquid. The steam power is generated and applied as in the ordinary engine; but upon the escape of the steam from the first cylinder, after having exerted its expansive force therein, it passes into an air-tight case, termed a vaporizer, containing a number of small tubes charged with perchloride, or some easily vaporized liquid, penetrates into the space between, and comes in contact with the entire surface of the tubes. The faculty of absorbing caloric, possessed by liquids of the before mentioned class, is so powerful, that immediately upon the steam coming in contact with the surface of the tubes charged therewith, a large portion of the caloric of the steam is absorbed by the liquid in the tubes, which becomes thereby vaporized, and the steam being thus deprived of its caloric, is immediately condensed and is then returned into the steam boiler. The vapor thus obtained by the action of the steam, or perchloride, or other liquid in the tubes, termed auxiliary vapor, is conducted into the second cylinder, and after exerting its elastic force (which is greater than steam) upon the piston in the second cylinder, is condensed, and by means of a force pump is returned into the vaporizer, which it thus keeps regularly supplied, and is alternately vaporized and condensed. The saving effected by this engine is in the small quantity of coals required for the steam, the smaller room occupied by it, and the avoidance of incrustation in the boiler, the water being completely distilled by the reiteration, vaporization, and condensation. The perchloride is a very cheap fluid; when once charged, the quantity in the tubes will last a considerable time, the alternate condensation and vaporization occasioning a very trifling loss in the bulk or quantity employed. Every liquid boiling at a low temperature can be used. The best, according to the trials, are sulphuric ether, sulphur of carbon, chloroform, chloride of carbon; the first two are inflammable, the last two are not."

Without discussing the *practical* merits of the invention, I should like to enquire if the same economic result could not be produced by using the easily vaporized liquid directly in the boiler itself. Second, what evil result (if any) would be produced by the oil, which has occasionally to be used in every working cylinder. In long voyages, this oil in the aggregate, amounts to a large quantity, and some means are absolutely necessary to get rid of it. Will not the mixture of oil with the easily vaporized liquid change in some way its nature? I hope that Mr. Du Trembley has accomplished all he states, and that his engine will prove something more than a model. FULTON.

For the Journal of the Franklin Institute.

Passage of the Steamer Baltic from Liverpool.

The Quickest Trip on Record, has been made by the steamer Baltic of the Collins line of steamers. She left Liverpool at 4 o'clock P. M., on Wednesday the 6th of August, and passed the battery at New York, at 20 minutes past 6, on Saturday morning the 16th. Apparent time 9 days, 14 hours, 20 minutes. Actual time 9 days, 18 hours, 45 minutes. She had good weather and fair winds for the greater part of the passage, and her daily run was as follows:—

Wednesday,	Aug.	6, left Liverpool, 4 p. m.		
Thursday,	"	7	12	m 245 miles.
Friday,	"	8	12	" 310
Saturday,	"	9	12	" 315
Sunday,	"	10	12	" 326
Monday,	"	11	12	" 315
Tuesday,	"	12	12	" 325
Wednesday,	"	13	12	" 324
Thursday,	"	14	12	" 312
Friday,	"	15	12	" 330
Saturday,	"	16 ar. at N. Y. 6-20 a. m.		237

On the arrival of the Baltic, the engineers of the Pacific presented to the engineers of the Baltic, the wreath of championship which they had received at the time they made their quick trip, it being well understood that the one who makes the quickest trip, is to have the custody of the said wreath, and is of course, by right, the champion of the line, to say nothing of the Canard steamers, which are now allowed to arrive and depart without note, so far as speed is concerned. H.

For the Journal of the Franklin Institute.

Lake Steamer Buckeye State.

This vessel, recently added to our lake fleet, has some peculiar features in her machinery, which render her worthy of special note. She has one of Smith & Baird's compound expansion annular beam engines, being the first of the kind applied to any steamer in this or any country; the whole has been arranged by Erastus W. Smith, Esq., engineer, of New York City, and is a good specimen of engineering. The peculiar feature of this engine, is the employment of two cylinders, one being situated within the other, both having the same stroke of piston. The small cylinder has a diameter of 37 inches, and a stroke of 11 feet, and into it the steam from the boiler of 40 lbs. average pressure is admitted, by a set of double balance valves, of the usual form. The larger cylinder surrounds the inner one, its diameter is 80 inches. The space between the two forms an annular chamber, and the large piston has two rods, and is packed on its inner and outer circumference; with this exception, the engine is of the usual form; but the advantage of admitting steam of high pressure, full stroke, or nearly so, on to the piston of the small cylinder, and expanding it into the large cylinder, must be apparent, as the great shock caused by the admission of steam of high pressure on to the area of a large piston, is almost entirely got rid of, and the method of expansion is more efficient. The following are some of the dimensions of the Buckeye State:—

		Feet.	Inches.
Length on Deck,		282	0
Breadth of Beam,		32	11
Depth of Hold,		13	0
Tonnage,	tons, 1187		
Diameter of Water Wheel,		35	0
Length of Paddles,		9	8
Depth " "		2	2
Dip of Wheel,		3	10
Average number of Revolutions,	16		
" Pressure of steam,	lbs. 40		
" Consumption of Bituminous Coal per hour,	" 3158		

While the Mayflower, a boat of about the same size and speed, consumes 6160 lbs per hour, showing a decided saving of fuel. She has three boilers with square fronts, 9 feet wide, and round shells 9 feet diameter, and in length 17 feet 9 inches. Each boiler has but one furnace, 8 feet wide, with grates 6 feet 6 inches long, with two lower flues of 20 inches diameter, and one of 26 inches; the return to the chimney, which is in front, is through 190 tubes of 3 inches internal diameter, which tubes rise 4 inches at the front end; whole number of tubes 570; diameter of chimney 6½ feet; height above grate, 65 feet; draft natural, and steam abundant; no trouble has yet been experienced from the great length of tube. It would be desirable to know the temperature in the chimney, as it is possible that the tubes may be longer than is necessary, as it has generally been supposed that very long tubes gave no additional evaporating power. This question is an important one, and I shall have it examined into, and will report at some future time. X.

Recent Improvements in Photography. *By* Robert Hunt.*

With the advance of this beautiful art there appears to be a progressively increasing desire to produce more artistic results; and numerous manipulatory improvements have recently been introduced, many of them with the most decided advantage. It is thought desirable, therefore, to devote a short space to the description and consideration of such of these as are the most important.

The use of collodion promises to be of exceeding importance. Collodion is a peculiar preparation, formed by dissolving gun-cotton in ether; it is a very mucilaginous solution, of a volatile character, and the ether evaporating, leaves a film of the utmost transparency behind. It is not all kinds of gun-cotton which dissolve equally well in ether; the most easily soluble is prepared by soaking good cotton in a saturated solution of nitrate of potash for some time: it is then, in a moist state, plunged into sulphuric acid, with which but a small quantity of nitric acid has been mixed. After remaining in the acid for about a minute, it is well washed with water, until no trace of an acid taste is discovered, and then dried at a temperature but very slightly elevated above that of the apartment.

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* From the London Art Journal for July, 1851.

Having obtained the collodion, the mode of proceeding best adapted for insuring success appears to be the following:

Iodide of silver is precipitated from a solution of the nitrate of silver by adding iodide of potassium to it, the yellow precipitate being well washed so as to remove every trace of nitrate of potash; it is then dissolved in a saturated solution of the iodide of potassium. This mixture is added in small quantities to the collodion, and the whole well agitated; by this means we obtain a combination of this peculiar substance with iodide of silver and potassium. Mr. Archer, who has devoted considerable attention to this preparation, prepares what he calls a collodoiodide of silver, whether in the above manner we are not certain. Mr. Archer's preparation is exceedingly sensitive, but the above is believed to be equally so. To use it, no other manipulation is necessary than to pour the mixture over a glass plate held upon the hand, moving the glass to and fro, to ensure the complete coating of every part; the fluid is poured off by one of the corners, and the film which adheres to the glass dries almost immediately. This is then washed over with the gallo-nitrate of silver, in the same manner as on the albuminised glass plates, and it is ready for the camera. Where the proportions have been happily hit upon, the result is the production of a picture almost instantaneously. Very fine portraits are obtainable in about ten seconds in diffused light; the image is developed in the same manner as in the calotype process, by the use of the gallo-nitrate of silver, and fixed by means of the hyposulphite of soda.

By the kindness of Mr. Horne we are enabled to add the following mode of operating. Mr. Horne has been so successful an operator with the collodion that we print his communication entire, that no part of his instructions may be lost:—

"The first article is the collodion, and most persons are aware that this is a solution of gun-cotton in ether, but, for the purpose now under consideration, should contain a small quantity of iodide of silver dissolved in excess of iodide of potassium. It should be sufficiently limpid to run freely over a plate when poured on, or ether must be added until this result is obtained. If the collodion is too thick, great difficulty will be experienced in obtaining an even coating; but when of a proper consistence, plates of any size may be readily coated.

"The plan which I have adopted, and with great success, is as follows:—Take a piece of flat glass cut to the size of frame, and, having washed it with water, and wiped the same quite dry, then, either by holding at one corner, or if large, placing it on a levelling-stand, pour on the centre of the plate a good body of liquid which will readily diffuse itself equally over the surface. Immediately pour the liquid off again into the bottle from one corner; and by bringing the hand holding the plate down a little, that the liquid may run to the lower edge, and drawing the mouth of the bottle along, those lines first formed will run one into the other, and give a flat even surface. Very little practice will soon enable any operator to obtain this result. The plate is now *immediately*, and before the whole of the ether has had time to evaporate, to be immersed in a bath of nitrate of silver, 30 grains to the ounce, *until the greasy appearance which it first presents on immersion is entirely gone, and the silver solution flows freely over the surface.*

"The plate should now, and in its moist state, be placed in the camera and the picture taken; the time of exposure varying, of course, with the light, but for a portrait, and with a moderately quick lens, from three to thirty seconds will be sufficient. Mr. Fry, who was the first to practise with collodion, has obtained beautiful portraits by placing the sitter in the open air, and simply removing the cap from the lens, and closing it again as soon as possible.

"The agent for developing these pictures is unquestionably the pyro-gallic acid, as recommended by Mr. Archer; and I am told the proto-nitrate of iron also answers equally well. The solution of pyro-gallic acid should be made as follows:—

Pyro-gallic acid, ...	3 grains.
Glacial acetic acid, ...	1 drachm.
Distilled water, ...	1 ounce.

The plate having been placed, face upwards, upon a levelling-stand, a sufficient quantity of the above solution should be poured equally and quickly over the surface, and the picture allowed to develop, occasionally slightly moving the plate, to prevent the deposit which will take place settling at one spot. A few drops of a solution of nitrate of silver, five grains to the ounce, may also, in dull weather, be added to the pyro-gallic, with advantage, just before pouring it over the plate; but in very bright weather the picture will develop sufficiently quick with the pyro-gallic acid solution alone.

"The development may be readily judged of by holding a piece of white paper occasionally under the plate; and as soon as sufficient intensity has been obtained, the solution must be poured off, and the plate washed by a gentle stream of water. After this, the surface should be covered with a saturated solution of hypo-sulphite of soda, which will almost immediately remove the iodide. Another stream of water must then again be poured over, to free the plate from hypo-sulphite, and the picture is finished.

"In this state they are more or less negative by transmitted light, and, if not too much brought out, positive by reflected light. But I have found the most beautiful and decided positives may be obtained by the simple addition to pyro-gallic solution of a minute quantity of nitric acid; care being taken not to add too much. I have also obtained purple and green pictures, the former by adding acetate of lead, and the latter with acetate of lime and ordinary gallic acid.

"In the hands of skilful operators, who have time and inclination to follow up this interesting branch of photography, I have little doubt but we shall see some beautiful results. At present it is quite in its infancy; but, notwithstanding this, it has been allowed by those who have seen the portraits which have been taken, that they possess far greater beauty than any hitherto produced."

The resulting negative picture on the glass is not quite so adherent as those formed with albumen; care must therefore be taken to avoid rubbing it off, or the glass plate may be covered with a colorless spirit varnish; by which, when dry, the photographic image is perfectly fixed. In this process the ether, without doubt, plays a very important part; although the largest portion evaporates readily, on intimate chemical combination of this hydro-carbon with the peculiar substance, gun-cotton, employed. At a very early period of photographic investigation, it was found that both alcohol and ether produced several remarkable effects—in some cases the processes were very much quickened; in others the resulting tone of the darkened paper was of a much deeper and richer color. Experiments are yet required to determine the operation of these organic compounds; from the action of many of them it would appear that it is to this order of chemical agents that we have now to look for the greatest improvements in photography.

Lactarine and caseine have been both recommended as media for preparing glass surfaces for the photographic processes. These compounds, which are of a very analogous character, are prepared from buttermilk, by the action of acids; it is proposed that they should be used in solution in ammonia. When this is done, the glass being uniformly coated by flooding the solution over it, it must be allowed to stand in a warm place, free from dust, to dry; this occupies some time, but if the process has been carefully attended to, the resulting coating is very uniform and clear. Iodide of potassium, or of ammonia, may be mixed with the caseine solution, before it is applied; the other parts of the process being precisely similar to those already described.

It has always been deemed of the utmost importance, in the processes on paper, to keep the chemical agents which are to be operated upon by the solar radiations as much as possible upon the surface. Several plans have been proposed, and albuminized paper, has been largely employed. It is, however, found that waxed paper answers far better than any other. The fact that water cannot be spread upon wax may appear to be a difficulty in the way of successful manipulation; but there are means by which this can be overcome, the most successful being the following:

A sheet of good writing paper is placed upon a hot iron plate, and rubbed over with wax until thoroughly saturated, taking care that the wax is uniformly diffused. If there should be an accumulation in any part, the paper is to be held up by one corner, in front of a fire sufficiently hot to liquefy it and allow it to flow off from the opposite corner. A great many sheets of this paper can be prepared at a time, and kept until required. To give these the sensitive coating, a large dish must be procured and filled with a solution of the iodide of potassium; if the paper is simply dipped in, and then removed, it will be found to remain quite dry, owing to the repulsive action exerted between the water and the wax. Sheets of waxed paper are to be passed into the solution one after another, taking care to remove any air-bubbles which may form on the surface of each, until as many as may be required are inserted, and the whole allowed to remain for two or three hours. In that time a considerable quantity of iodide of potassium has been absorbed, and, on removing the papers and drying them, it will be found, upon the application of the nitrate of silver, that a beautiful surface of the iodide will be produced. These papers are highly sensitive, whether we employ the calotype or the ferrotype process, principally from the circumstance that the chemical agents are retained on their very surface. The resulting pictures are beautifully transparent, not in any respect inferior for copying from than those negatives which are waxed after the picture has been obtained, and all the details are very charmingly preserved.

The addition of the flouride of sodium to the iodide or chloride, is the first preparation of the paper we have alluded to, and there can be no doubt but it possesses considerable accelerating power. This preparation has been recently introduced as a novelty, but the following process is described in the author's "Researches on Light," published in 1844:—

"The fluates of soda and of potash have been used in many different manners, and variously combined. It has been found that the fluate of soda, has the property of quickening the sensibility of bromidated papers to a very remarkable extent; and from this quality, a new process, which I would distinguish by the name of the Fluorotype results. THE FLUOROTYPE. This process, which is characterized by its easy manipulation, and by the sensibility of the papers, when carefully prepared, consists in the formation of a salt of silver, which I suppose must be considered as a fluo-bromide of silver. It is at present somewhat difficult to say which is the most efficacious manner of proceeding; but the difference, as it regards the sensibility of papers, is so very trifling, that this is not of much consequence. The paper may be washed, first, with the bromide of potassium, and then with the fluate of soda; or, which will be found on the whole the best plan, the two salts may be united. The strength of the solution should be as follows:—

Bromide of potassium	20 grains.
Distilled water	1 fluid ounce.
Fluate of soda	5 grains.
Distilled water	1 fluid ounce.

Mix a small quantity of these solutions together when the papers are to be prepared, and wash the paper once over with the mixture, and when dry apply nitrate of silver in solution, 60 grains to an ounce of water. These papers appear to keep for some weeks without injury, and they become impressed with good images in half-a-minute, in the camera. This impression is not sufficiently strong to serve, in the state in which it is taken from the camera, for producing positive pictures, but it may be rendered so by a secondary process. The photograph is first soaked in water for a few minutes; it is then placed upon a slab of porcelain or stone, and a weak solution of the proto-sulphate of iron applied, which very readily darkens all the parts on which the light has acted, to a dark brown; and every object is brought out with great sharpness. When the best effect is produced, the process must be stopped, or the lights suffer. All that is necessary is to soak the paper in water, and then fix with hypo-sulphite of soda."

The processes now recommended are in all respects similar to this:—

It has been found in operating upon landscapes, that the best effects are produced by employing weak solutions of the gallo-nitrate of silver; by choosing clear daylight rather than sunshine—and then allowing the paper to remain in the camera obscura for a prolonged period; that is, from half-an-hour to an hour. In this manner, all the delicate details are brought out—every blade of grass and every leaf impresses its shadow on the paper, and there are not any of those violent contrasts which destroy the picturesque harmony of many of the calotype landscapes.

The "Daguerreian Journal," published in New York, has just announced the discovery, by Mr. Hill, of a process of obtaining photographs colored by Nature. The manipulatory details are not complete; but we quote Mr. Hill's own words, hoping his expectations may be fully realized:—

"Some two years ago, I took to experimenting, with a view to this great desideratum, but with little faith. In one of my experiments a phenomenon presented itself which greatly surprised me, and, in the nature of the case, compelled me to believe the thing practicable. One color, the red, in a figured dress, was developed as bright as a ruby. I then repeated the experiment, and failed; but, from that hour until a few months ago, I continued to repeat it in every form I could think of, always failing, but never despairing; for I had reasons for believing in the correctness of my theory, that, under certain circumstances, there is on the impressioned plate a latent-colored image. I at length commenced experimenting on the developing power of the vapors of different metals, and found that a large number of them, such as arsenic, cadmium, zinc, selenium, bismuth, potassium, and sodium, would, when properly vaporised, bring out the latent image in light and shade. The same result followed the use of several gases; the impressions differed so little from daguerrotypes, that I was on the point of abandoning the pursuit, when I one day, unexpectedly, formed a singular compound, and, without much hope of success, applied it to my purpose.

"My surprise and joy were unbounded when I found on my plate a true Hillotype. The same process, with some variations, I have followed since, always with good results. I now have forty-five specimens, all of which present the several colors, true to a tint, and with a degree of brilliancy never seen in the richest daguerreotype, and this is true also of the whites and blacks. The pictures have much the appearance of an enamelling, and, I believe, are equally durable, for it is very difficult to efface them by scouring; and, as far as I can judge, they are not acted upon by light. My process bears no resemblance to Becquerel's, and is essentially different from Daguerre's. My success in quickening the plates has been equally gratifying, and I have but little doubt of being able to operate in diffusing light instantaneously, having already reduced the time of setting to much less than that required for daguerreotyping. I have now forty-five specimens; they are all equally perfect. It is quite remarkable that I have never yet made a partial failure. Those impressions which have had too much light, are nearly as strong, sound, brilliant, and beautiful, as those correctly timed in the camera; being inferior only in having the colors less deep; even the whites retain their strength. The folds of the linen are always well defined; blue or solarised linen is unknown in my process, and there is always a strength and clearness in the whites unattainable by mercury. During the last winter I have several times taken a view, in which there is a deep red house, while the ground was covered with snow. For experiment I exposed the plate so long as to reduce the bright red of the house to a very light red, while, at the same time, the white snow was developed with a beautiful whiteness. I have copied several very highly colored French prints; the copies are far superior to the originals, in that, while they have every tint of color, they are exceedingly brilliant. This is a characteristic in which I never fail, even with the plates merely cleaned with rotten-stone; the brilliancy depending on other causes. Well-polished plates, however, are preferable, for other reasons. It is essential that the plates should be very pure, free from scum, dampness, and organic matter of every kind; and I am experimenting with different substances, in hopes of finding something that will more perfectly cleanse, while it thoroughly polishes. I would be very thankful to any person who might furnish me with valuable hints on this point, as I am convinced that here lies one great cause of uncertainty."

In America there is certainly much zeal displayed in the cultivation of the art of photography. Many of our greatest advances in the art originated in the United States; the first portraits from the life being taken in New York by the professor of chemistry. We are now promised a process by which the great desideratum of impressed color is to be obtained; and the advertising columns of our Journal contain the offer of a prize of 500 dollars for the most important improvement in the art of photography, during the current year. The advantages of stimulating enquiry by offers of this kind, are numerous, and we have but little doubt but that Mr. Anthony's prize will be contested for by the photographic artists and amateurs both in Europe and in America. We hope the result may be the development of some new process by which, with ease and certainty, we may be enabled to obtain still more perfect reflexes of nature than those afforded by the processes we already possess.

Specification of a Patent granted to John Mercer, *of Oakenshaw, Lancashire, for improvements in the preparation of cotton and other fabrics and fibrous materials.*—[Sealed 24th October, 1850.]*

This invention consists in subjecting cotton, flax, and other vegetable fibrous material, and fabrics made therefrom, either alone or mixed with silk, wool, or other animal fibrous material, to the action of caustic soda, or caustic potash, or dilute sulphuric acid, or a solution of chloride of zinc, of such strength and at such a temperature as will produce the effects hereafter mentioned.

The mode of operating, according to this invention, upon cloth made wholly or partially of any vegetable fibres, and bleached, is as follows: The cloth is passed through a padding machine, charged with caustic soda or caustic potash at 60° or 70° of Twaddle's hydrometer, (sp. gr. 1·3 or 1·35,) at the common temperature of the atmosphere, (say 60° Fahr., or under;) then, without being dried, it is washed in water; and, after this, it is passed through dilute sulphuric acid, and washed again. Or the cloth is conducted over and under a series of rollers in a cistern containing caustic soda or caustic potash at 40° to 50° Twaddle, (sp. gr. 1·20 or 1·25,) at the ordinary temperature (the last two rollers being set so as to squeeze the excess of soda or potash back into the cistern); and then it is passed over and under rollers placed in a series of cisterns, which are charged at the commencement of the operation with water only; so that when the cloth arrives at the last cistern, nearly all the alkali has been washed out of it. After the cloth has either gone through the padding machine or through the cisterns, it is washed in water, passed through dilute sulphuric acid, and again washed in water.

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* From the London Journal and Repertory of Arts and Sciences, for June 1851.

When grey or unbleached cloth, made from the above mentioned fibrous material, is to be treated, it is first boiled or steeped in water, so as to wet it thoroughly; then most of the water is removed by the squeezers or hydro-extractor; and, after this, it is passed through the soda or potash solution, &c., as before described.

Warps, either bleached or unbleached, are treated in the same manner; but, after passing through the cistern containing the alkali, they are passed through squeezers or through a hole in a metal plate, to remove the alkali; and then the warps are conducted through the water cisterns, "soured," and washed, as above described.

When thread or hank yarn is to be operated upon, the threads or yarns are immersed in the alkali and then wrung out (as is usually done in sizing or dyeing them); and afterwards they are subjected to the above mentioned operations of washing, souring, and washing in water.

When any fibre in the raw state, or before it is manufactured, is to be treated, it is first boiled in water, and then freed from most of the water by the hydro-extractor or a press; after which it is immersed in the alkaline solution, and the excess of alkali is removed by the hydro-extractor or a press; then it is washed in water, soured with dilute sulphuric acid, and washed again; and finally the water is removed by the hydro-extractor or a press.

The following are the effects produced by the above operations upon cloth made of vegetable fibrous material, either alone or mixed with animal fibrous material:—The cloth will have shrunk in length and breadth, or have become less in its external dimension, but thicker and closer; so that by the chemical action of caustic soda or caustic potash on cotton and other vegetable fabrics, an effect will be produced somewhat analogous to that which is produced on woollen by the process of fulling or milling. The cloth will likewise have acquired greater strength and firmness,—greater force being required to break each fibre. It will be found to have become heavier than it was previously to being acted upon by the alkali; if in both cases it be weighed at the temperature of 60° Fahr., or under. It will also have acquired greatly augmented and improved powers of receiving colors in printing and dyeing.

The effects resulting from the above treatment of the vegetable fibre, in any of its various stages, before it is made into cloth, will be readily understood from the statement of the effects produced on cloth, composed of such fibre, by treating it according to this invention.

Secondly, the patentee employs diluted sulphuric acid, at 105° Twaddle, (sp. gr. 1·52,) and at 60° Fahr., or under, instead of caustic soda or caustic potash—the operation being the same as when soda or potash is used, except the last souring, which is now unnecessary.

Thirdly, the patentee uses a solution of chloride of zinc, at 145° Twaddle (sp. gr. 1·72,) and from 150° to 160° Fahr., instead of the soda or potash, and in the same manner.

When operating on mixed fabrics, composed partly of vegetable fibres and partly of silk, wool, or other animal fibres, such as delains, it is preferred that the strength of the alkali should not exceed 40° Twaddle, nor the temperature be above 50° Fahr., lest the animal fibres should be injured.

The apparatus and the temperature and strength of the soda or potash, sulphuric acid, or chloride of zinc solution, may be varied to a considerable extent, and will produce proportionate effects: for instance, the soda or potash may be used at a strength even as low as 20° Twaddle, (sp. gr. 1.10,) and still give improved properties to cotton, &c., for receiving colors in printing and dyeing, particularly if the temperature be low; for the lower the temperature, the more effectually the soda or potash acts on the fibrous material. The patentee does not, therefore, confine himself to any particular strength or temperature; but he prefers the strength, heat, and process above described.

He claims, as his invention, the subjecting of cotton, linen, and other vegetable fibrous material, either in the fibre or any stage of its manufacture, either alone or mixed with silk, woollen, or other animal fibrous material, to the action of caustic soda or caustic potash, dilute sulphuric acid, or solution of chloride of zinc, of a temperature and strength sufficient to produce the new effects and give to them the new properties above described, either by padding, printing, or steeping, immersion, or any other mode of application.—[*Inrolled April*, 1851.]

On a new Method of Contracting the Fibres of Calico, and of Obtaining on the Calico thus prepared Colors of much Brilliancy.[*]

Mr. Mercer had his attention drawn to the subject by experiments made as early as 1844. Dr. Playfair briefly called attention to the states of water, the points of maximum density so well known, and the experiments of Mr. Mercer, who found that above this point water flowed more rapidly through a syphon than at the same number of degrees below this point of maximum density. He then spoke of the theoretical views of those chemists who look upon the combined water as in the state of ice, or free from fluidity. Mr. Mercer's discovery may be stated in few words to be this:—a solution of cold but caustic soda acts peculiarly upon cotton-fibre immediately causing it to contract,—and although the soda can be readily washed out, yet the fibre has undergone a change, and water will take its place and unite with the fibre. In a practical view Mr. Mercer considered that the fibre might be considered by this action to have a sort of acid property to unite with soda and then with other bases. The effect of the condensation was said to be one-fifth to one-third of the total volume of cotton employed. Dr. Playfair then showed some proofs of the influence of this new process upon our cotton manufactures; thus, taking a coarse cotton fabric and acting upon it by the proper solution of caustic soda, this could be made much finer in appearance; and if the finest calico made in England, known as 180 picks to the web, was thus acted upon, it immediately appeared as fine as 260 picks. Stockings of open weaving were shown, and the condensation process made them appear as of much finer texture. The effect of this alteration of texture was most strikingly shown by colors. The pink cotton velvet had its tint deepened to an intense degree by the condensation process. Printed

[*] From the London Athenaeum, for July, 1851.

calico, especially with colors hitherto applied with little satisfaction, as lilac, had strength and brilliancy, besides thus producing fabrics cheaply finer than can possibly be woven by hand. The effect was shown of patterns being formed by portions of a surface being protected by gum from condensation. Thus patterns of apparently fine work can easily be produced. It was stated that the fabrics by this process have much strength given them: for a string of calico one-half condensed by caustic soda will break by 20 oz., while the unacted-upon string of cotton broke with 13 oz.

A discussion ensued, by the remarks of Dr. Faraday, Mr. Warrington, and Prof. Dumas and others; and it was proposed that the microscope be employed to ascertain any other obvious change of properties by this new process, that bids fair to exercise an immediate and extensive alteration in the patterns and produce of cotton fabrics. Dr. Playfair, in reply, said, that caustic soda had long been used for bleaching, but this power of altering the texture only belongs to the cold solution of caustic soda. These specimens were the only complete ones, and he had been permitted to bring them from the Great Exhibition to exhibit before the Association.—*Proc. Brit. Asso. for Prom. Sci.*

For the Journal of the Franklin Institute.

Gravitation from the Surface of the Earth to its Centre. By John W. Nystrom.

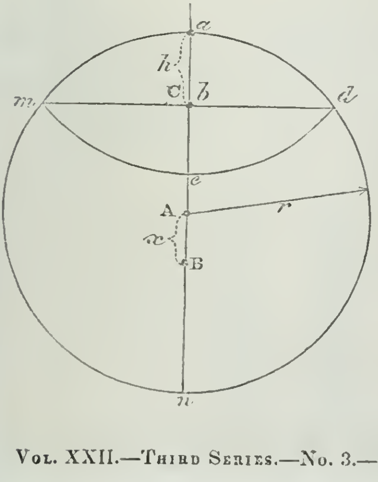
Let A be the whole mass of the Earth, or $A=a\,d\,n\,m$, and a the value of gravity on the surface of the Earth, and r its radius. According to Newton's law,

$$a=\frac{A}{r^2}. \qquad \qquad (1.)$$

But at a depth$=h$, from the surface to a point b on the inside of the Earth, the value of gravity will not be $b=\frac{A}{(r-h)^2}$; the *half lens* $a\,d\,b\,m$ attracts the point b upwards in the direction of $b\,a$. To counterbalance this upward attraction requires another *half lens* $b\,d\,e\,m=a\,d\,b\,m$ below the point b, and the remaining mass, $m\,e\,d\,n=B$, is the mass which attracts the point b downwards. The value of gravity will be

$$b=\frac{B}{(r+x-h)^2}, \qquad (2.)$$

when x denotes the distance from the centre of gravity of A to the centre of gravity of B.



Let the mass of the lens $a\,d\,e\,m = \mathrm{C}$; then by taking the statical momentum of the two masses B and C, we have

$$\mathrm{B}\,x = \mathrm{C}\,(r - h)$$

and
$$x = \frac{\mathrm{C}\,(r - h)}{\mathrm{B}.} \quad . \quad . \quad . \qquad (3.)$$

$$\mathrm{A} = \mathrm{B} + \mathrm{C}, \text{ and } \mathrm{B} = \mathrm{A} - \mathrm{C},$$

but
$$\mathrm{A} = \frac{4\pi r^3}{3,} \quad . \quad . \quad . \qquad (4.)$$

and
$$\mathrm{C} = \frac{2\pi h^2}{3}(3r - h). \quad . \quad . \quad . \qquad (5.)$$

$$\mathrm{B} = \frac{4\pi r^3}{3} - \frac{2\pi h^2}{3}(3r - h) = \frac{2\pi}{3}(2r^3 - h^2[3r - h]), \qquad (6.)$$

from the equations 1 and 2 we obtain $a : b = \frac{\mathrm{A}}{r^2} : \frac{\mathrm{B}}{(r + x - h)^2}$ from there we get

$$b = \frac{r^2 a\,\mathrm{B}}{\mathrm{A}\,(r + x - h)^2.} \quad . \quad . \quad . \qquad (7.)$$

by insertion of the value of B and C (6 and 5) in the equation 3 will be

$$x = \frac{\mathrm{C}\,(r - h)}{\mathrm{B}} = \frac{\frac{2\pi h^2}{3}\,(3r - h)\,(r - h)}{\frac{2\pi}{3}\,(2r^3 - h^2[3r - h]).}$$

of which
$$x = \frac{h^2\,(3r - h)\,(r - h)}{2r^3 - h^2\,(3r - h),} \quad . \quad . \qquad (8.)$$

by insertion of the value of A and B (4 and 6) in the equation 7 we obtain

$$b = \frac{a\,r^2\,\mathrm{B}}{\mathrm{A}\,(r + x - h)^2} = \frac{a\,r^2\frac{2\pi}{3}(2\,r^3 - h^3[3r - h])}{\frac{4\pi r^3}{3}(r + x - h)^2}$$

$$b = \frac{a\,(2r^3 - h[3r - h])}{2r\,(r + x - h)^2.} \quad . \quad . \qquad (9.)$$

Let $a = 10$, $r = 10$, then x and b being calculated from the formula 8 and 9 at every 10 parts of r, it will be as in the following table.

	h.	b.	x.
	1	11·75	0·133
	2	13·15	0·475
	3	13·39	0·973
Maximum for b.	3·333	14·1	1·15
	4	13·8	1·575
	5	13	2.262
	6	11·45	3·035
	7	9·19	3·88
	8	6·45	4·765
	9	3·265	5·735
	10	0	10·

Suppose the earth to have no rotation around its axis, and a hole be dug from the surface through the centre of the earth, then let a body be dropped in that hole, the time for its fall from the surface to the centre would be, $T=\sqrt{\frac{R}{g}},$ if the value of $g=16{\cdot}08$ would remain the same through the hole or falling space; R=radii of the earth in feet. But the foregoing table shows that g increases until one-third of the distance, where it is a maximum. After that it diminishes until it comes to the centre, there $g=o;$ but the body has then obtained a certain velocity, and continues its motion towards the opposite side of the earth, there it will return in the same degree until it reaches its dropping point, where it again returns to its first returning point, and will so continue an alternate motion for ever, supposing the hole is empty.

The different values of g at different depths D. is apparent from the foregoing table, $g, {}^1g\ {}^2g\ {}^3g \ldots\ldots {}^{10}g=bg$, and the true time for its fall from the surface to the centre will be

$$T=\frac{R}{\sqrt{\frac{R}{10}}\sqrt{g}+\sqrt{{}^1g}+\sqrt{{}^2g}\ldots+\sqrt{{}^{10}g}.}$$

or let $\sqrt{g}+\sqrt{{}^1g}+\sqrt{{}^2g}\ldots+\sqrt{{}^{10}g}=G,$

we have
$$T=\frac{R}{G\sqrt{\frac{R}{10},}}$$

or at any depth D expressed in feet from the surface,

$$T=\frac{D}{G\sqrt{\frac{R}{10}}}$$

If V denotes the velocity in feet per second at any depth, D and G taken from its corresponding depth,

we have
$$V=2G\sqrt{\frac{R}{10.}}$$

The following table will show the different values of T and V. The radius of the earth being R=20935200 feet.

Space fallen through in the first second at depth D. $bg.$	$\sqrt{gb.}$	G.	Time in seconds for the space fallen thro'. T.	Velocity in feet per second at the depth D. V.	Depth from the surface in feet. D.
$16{\cdot}08=g$	4·01	4·01	0	0	0
$18{\cdot}9\ ={}^1g$	4·35	8·36	173	24200	2093520
$21{\cdot}1\ ={}^2g$	4·6	12·96	223	37600	4183040
$22{\cdot}3\ ={}^3g$	4·72	17·98	245	51200	6280560
$22{\cdot}2\ ={}^4g$	4·7	22·33	259	64800	8374080
$20{\cdot}9\ ={}^5g$	4·57	26·95	268	78000	10467500
$18{\cdot}4\ ={}^6g$	4·29	31·24	277	90700	12561120
$14{\cdot}8\ ={}^7g$	3·8	35·04	289	101500	14654640
$10{\cdot}4\ ={}^8g$	3·23	38·23	300	111000	16748160
$5{\cdot}26={}^9g$	2·29	40·56	322	117500	18841680
$0={}^{10}g$	0	40·56	353	117500	20935200

We see by this table it takes 357 seconds, or nearly 6 minutes to fall from the surface to the centre, or 24 minutes to make a passage through the earth and back again. The velocity at the centre will be 117500 feet, or 22·25 miles per second.

Philadelphia, August 1851.

For the Journal of the Franklin Institute.

A List of Steamers in course of Construction in Baltimore, together with their Dimensions, &c.

I. Palmetto Propeller.—The first of a line of steamers to be established between Baltimore and Charleston, S. C. Builder, J. A. Robb; Engines by C. Reeder, Jr.

Length on Deck, ...	186 feet.
" of Keel, ...	172 "
" between Perpendiculars, . .	175 "
Breadth of Beam, ...	30 "
Depth of Hold, ...	18 "
Dead Rise, ...	10 inches.
Tonnage (custom house measurement), .	750 tons.

Immersed sectional area at load line, or direct resistance, 224 sq. feet.

Two Direct Action Engines, with Vertical Cylinders.

Diameter of Cylinders, . . .	44 inches.
Stroke of Pistons, ...	40 "
Diameter of Air Pump, . . .	28 "
Stroke of Air Pump Piston, . . .	20 "

Slide Valves.—Steam Ports, 4 × 20; Exhaust do., 4 × 20.

Two Cylindrical Iron Boilers, with double return flues. Length, 16 feet; Diameter, 9½ feet. Fuel, Bituminous Coal.

One Cast Iron Propeller. Diameter 11½ feet; Face, 40 inches; Pitch, 23½ feet. Propeller surface, 98 square feet, being a proportion of propelling surface to area of direct resistance as 1 to 2·28. Length of Propeller shaft, (3 sections,) 72 feet; diameter of do., 10 inches; journals of do., 10 × 12 inches.

The *Palmetto* is a fine looking vessel, with excellent lines of flotation. Three masted, schooner rigged, with foresail, foretopsail, and foretopgallantsail.

II. General McDonald.—For the Philadelphia line, to run in connexion with the *Robert Morris* on the Delaware. Builder, J. S. Brown; engine re-built by C. Reeder, Jr.

Length on Deck, ...	225 feet.
Breadth of Beam, ...	30 "
Over Guards, ...	54 "
Depth of Hold, ...	9 "
Draft of Water, ...	4¾ "

Hollow lines, coppered and copper fastened.

One Beam Engine, re-built, having been in use for several years on board the late steamer *Constitution.*

Diameter of Cylinder,	52 inches.
Stroke of Piston,	10 feet.
Diameter of Air Pump	40 inches.
Stroke of Air Pump Piston,	44 inches.

Two Iron Boilers, arch and tubular. Fire and flue surface, about 3000 square feet; fuel, wood.

Length of Boilers,	17½ feet.
Breadth,	9 “
Height in front,	10 “
“ at back,	8½ “
Diameter of Flues, (internal,)	3 inches.
Diameter of Water Wheels,	31 feet.
Face “ “	8½ “
Depth of Buckets,	30 inches.
Diameter of Water Wheel Shaft, (wrought iron,)	13 “

III. A side wheel steamer for Savannah, Georgia. R. & E. J. Bell, builders; engine by C. Reeder, Jr.

Length on Deck,	130 feet.
Breadth of Beam,	20 “
“ over Guards,	34 “
Depth of Hold,	7½ “

One Beam Engine.

Diameter of Cylinder,	24 inches.
Stroke of Piston,	8 feet.
Diameter of Air Pump,	18 inches.
Stroke of Air Pump Piston,	42 “

One Cylindrical Iron Boiler.

Length of Boiler,	15½ feet.
Diameter “	7½ “

Double return flues, fire and flue surface, 800 square feet; fuel, wood.

Diameter of Water Wheel,	22 feet.
Face of “ “	5 “
Depth of Bucket,	20 inches.
Diameter of Shafts, (wrought iron.)	7 “

IV. A side wheel steamer for La Guayra, South America. Builder, —— Gardner; engines by Murry & Hazelhurst, Vulcan Works.

Length on Deck,	132 feet.
“ between Perpendiculars,	130 “
Breadth of beam,	21 “
“ over Guards,	34 “
Depth of Hold,	9 “
Tonnage (custom house measurement),	250 tons.

Has a drop deck and is a three masted schooner rigged. Is supplied with two steeple engines connected.

Diameter of Cylinders,	28 inches.
Stroke of Piston,	48 “

One double acting air pump, worked from crank motion of centre shaft.

Diameter of Air Pump.	$18\frac{5}{8}$ inches
Stroke of " " Piston,	24 "

One Iron Boiler; Double return flues.

Length of Boiler,	$15\frac{1}{2}$ feet.
Width of "	$10\frac{1}{4}$ "
Height of "	11 "

Heating Surface, 1000 feet; Fuel, Soft Coal.

Diameter of Water Wheel,	$15\frac{1}{2}$ feet.
Face of " "	$5\frac{1}{2}$ "
Depth of Buckets,	20 inches.

Hanging Wheel.

V. A large steamer for the Powhattan Co., The "Belvedere;" Freight and Passengers to Richmond, Va. Builders, Cooper & Butler; engine by Murry and Hazelhurst, Vulcan Works.

Length on Deck,	225 feet.
" between Perpendiculars,	210 "
Depth of Hold,	12 "
Breadth of Beam,	34 "
" over Guards,	58 "
Draft at load line,	9 "
Tonnage (custom house measurement),	840 tons.

Line of Flotation slightly concave.

One Beam Engine.

Diameter of Cylinder,	50 inches.
Stroke of Piston,	10 feet.
Diameter of Air Pump,	3 "
Stroke of Air Pump Piston,	$4\frac{1}{3}$ "
Area of Steam Valves,	230 sq. inches.

One Iron Boiler, Single Return Flues.

Length of Boiler,	24 feet.
Height of "	13 "
Width of "	$11\frac{1}{2}$ "
Diameter of cylindrical part,	11 "

Heating surface, 2200 feet; Fuel, Wood.

Diameter of Water Wheel,	29 feet.
Face " "	$9\frac{1}{2}$ "
Depth of Bucket,	$2\frac{1}{4}$ ft.

Buckets radiated from centre of shaft. The "B" is to fill the place of the "Columbus," recently burnt, belonging to the same company.

VI. A side wheel Steamer for the Norfolk line, Bay route; Builders, Cooper & Butler; Engine by Murry and Hazelhurst, Vulcan Works.

Length on Deck,	245 feet.
" between Perpendiculars,	237 "
Breadth of Beam,	34 "
" over Guards,	60 "
Depth of Hold,	11 "
Draft at load line,	6 "
Tonnage, (custom house measurement,)	864 tons.

One Beam Engine.

Diameter of Cylinder,	56 inches.
Stroke of Piston,	11 feet.
Diameter of Air Pump,	44 inches.
Stroke of Air Pump Piston,	50 "

Two Iron Tubular Boilers.

Length of Boilers,	14 feet.
Width "	14 "
Height "	11 "

Arch below and returns through 4 inch tubes; Fuel, Bituminous Coal; Heating surface, 4000 square feet.

Diameter of Water Wheels,	32 feet.
Face " "	9½ "
Depth of Bucket,	2½ "

Buckets radiate from centre of shaft.

The company to whom this boat belongs will find, to their regret, that they have limited the engineers in the size of her cylinders injudiciously. A reservation of power in the capacity of a cylinder to meet exigencies that occur during the winter passages on that route, would certainly more than pay the difference in the first cost in a short time, between a 56 and 60 inch cylinder, in the certainty of her time, and a reduced amount of wear and tear in machinery, owing to the fact that forcing her will be unnecessary.

I have for comparison taken the steamer Vanderbilt, running on the Long Island Sound.

Vanderbilt,	tonnage,	1041,	capacity of Cylinder,	339 cubic feet.
Norfolk Boat,	"	864	" "	188 " "

Vanderbilt cylinder, capacity to tonnage is as	1 to 3·07
Norfolk Boat, " " "	1 to 4·05

Thus showing a proportion of power to tonnage, largely in favor of the Vanderbilt, a boat having very similar duties to perform, to that of the Norfolk boats.

S.

For the Journal of the Franklin Institute.

Photographs in Colors.

For the last few months our journals have been occupied with the reported discovery, by a gentleman in the State of New York, of a method of obtaining photographic images of objects in their natural colors, and much anxiety has been expressed to see his pictures. Mr. Hill has not thought proper to publish his process yet, and in the meantime the same results have been arrived at in France.

On the 7th of February, 1848, M. Edmond Becquerel sent to the Academy of Sciences, at Paris, a description of a method of preparing silver plates so as to obtain an image of the solar spectrum. This communication was reported on, (12th Feb., 1849,) by a committee consisting of MM. Biot, Chevreul, and Regnault, and on their recommendation the memoir was directed to be printed in the collection of memoirs presented to the Academy by persons not members. (*Recueil des Savants Etrangers.*)

Since this, several other notices on the subject, by M. Becquerel, will be found in the *Comptes Rendus* of the Academy, and on the 2d June last M. Niepce sent a communication on the same subject. Neither of these gentlemen were, however, able to fix their images, and it was accordingly necessary to keep them in the dark, but, in the *Comptes Rendus* for 21st July last, we find the following announcement:—

"M. Letillois announces that he has discovered a colorless liquid by means of which he can *fix in a durable manner, upon white paper, all the colors of the prism.* (The italics are the reporter's.) Two specimens of paper thus prepared accompany the note, and present, in truth, colors which, at certain incidences of the light, are very bright and very pure.

"M. Letillois thought that he could obtain the approbation of the Academy for this discovery, by communicating to one member, whom he designates, his process, which he might in other respects keep secret. The usages of the Academy do not permit them to accede to a request made under these conditions."

It is evident that if Mr. Hill desires to have any credit for his invention, he must publish it promptly, as it is probable that the next numbers of the Academy's proceedings will give us M. Letillois' process. F.

For the Journal of the Franklin Institute.

Oscillating Engines for Marine Steamers.

Since the introduction of oscillating engines in the steamers Golden Gate and Illinois, at New York, our friends in that city are disposed to claim the originality of their introduction in this country. They forget that the steamer Republic, built by Murry & Hazelhurst, in 1849, had a pair of engines of that kind, with cylinders 54 inches diameter, and 6 feet stroke; and that since that time, they have put a pair in the Monumental City, diameter of cylinder 44 inches, and 3 feet stroke. T. J. Sutton & Co., of this city, have also built two pair; one for the steamer Col. Fremont, now in the Pacific, and the other in the Albatross, running between this port and Charleston. All of these have been built and put in operation before those of the Golden Gate and Illinois.

For the Journal of the Franklin Institute.

Steamers Building in Philadelphia, August 1st, 1851.

At the works of Merrick & Son, Engineers, Southwark, steamer *Corwin*, belonging to the U. S. Coast Survey. Hull by Vaughan & Lynn, of Kensington.

Length,	125 ft.	
Depth of Hold,	10 "	
Breadth of Beam,	24 "	
Average draft of Water,	7 "	
One Steeple Engine.		
Diameter of Cylinder,	4 ft.	2 in.
Length of Stroke,	4	
Diameter of Paddle Wheels,	17	6
Length of Paddles,	5	6
Depth of "	1	8

Two Vertical Tubular Boilers, 4 feet 10 inches wide, 16 feet 2 inches long, 8 feet 3 inches high; draft natural; fuel, bituminous coal.

This vessel is built expressly for the Coast Survey service and has

Bunkers for 100 tons of bituminous coal, while her daily consumption on duty will not exceed five tons.

Messrs Merrick & Son have also in hands the machinery for the first vessel of the line now building to run between this City and Savannah, She is to have one side lever engine, cylinder 6 feet diameter and 8 feet stroke; two boilers with horizontal return tubes (internal diameter 3 inches) 9 feet 6 inches long; width of boilers 12 feet; length 14 feet, and height 10 feet 10 inches. Each boiler has 4 furnaces 7 feet 6 inches long. The fuel is to be anthracite coal, with natural draft. Diameter of paddle wheels 29 feet 4 inches, width 9 feet 3 inches, depth of paddles 1 foot 10 inches. The hull is building by Vaughan & Lynn, of Kensington, and is 200 feet long, 33 feet beam, and 21 feet hold, she is expected to equal the steamers Florida and Alabama, now running between New York and Savannah.

Messrs. Reaney, Neafie & Co., of the Penn Iron Works, have in hands the machinery of the Boston steamer William Penn. She has two Vertical direct action Engines, cylinders over cranks.

Diameter of Cylinders, . . .	2 ft.	10 in.
Length of Stroke, . . .	2	10
Diameter of Propeller, . . .	10	
Number of Blades . . .	4	
Pitch at Centre of Pressure, . . .	20 ft.	8 in.
Two Boilers (each) in length, . .	21	

With a front of 8 feet in width, and same diameter of Shell.

Each boiler has two furnaces with grates 5 feet 3 inches long. There are to each boiler 6 lower flues, and 18 upper return flues; diameter of the latter 7 inches. There is but one chimney, 45 feet high above grate, and five feet diameter. Each engine has an air pump and condenser, the former is so geered that while the piston of the engine makes two double strokes the air pump bucket makes but one. The fuel to be used is anthracite coal, with fan blast. The hull of this vessel is by Birely & Son.

Length on Deck, ...	180 ft.	
Breadth of Beam, . . .	26 "	
Depth of Hold, ...	19	6

Also the Machinery of the Steamer West Wind, intended for the California trade. She has two vertical direct action engines.

Diameter of Cylinders, . . .	2 ft.	6 in.
Length of Stroke, ...	2	2
Diameter of Propeller, . . .	8	2
Pitch at Centre of Pressure, . . .	18	6

Pirssons fresh water Condenser is used; the air pumps are direct action, and worked from the cross-heads of the engines. There is one boiler 20 feet long, with a front 9 feet 6 inches wide, diameter of shell 9 feet; two furnaces with a grate 5 feet 4 inches long; 8 lower flues, and 18 upper flues, the latter 8 inches diameter. One chimney, height above grate 38 feet, diameter 3 feet 6 inches. Anthracite coal is to be used with natural draft. Hull by Messrs. Thatcher, of Wilmington, Del.

Length on Deck, . . .	160 ft.
Breadth of Beam, ...	28

Also for the Steamer City of Richmond, to run from New York to Norfolk and Richmond.

Two vertical direct action engines.

Diameter of Cylinders,	2 ft.	2 in.
Length of Stroke,	2	2
Diameter of Propeller,	8	2
Pitch at Centre of Pressure,	18	6

Two air pumps and condensers, the former direct action, with canvass valves. One boiler 22 feet long, 8 feet wide; diameter of shell 7 feet 6 inches; 6 lower flues, and 16 return flues, the latter 7 inches diameter. Two furnaces with grates 5 feet 3 inches long; one chimney 3 feet diameter. Hull by Tees & Birely.

Length on Deck,	153 ft.
Breadth of Beam,	25
Depth of Hold,	17

Also for a steamer to run from Boston to Bangor.

Two vertical direct action engines.

Diameter of Cylinders,	2 ft.	6
Length of Stroke,	2	2
Diameter of Propeller,	9	
Pitch at Centre of Pressure,	20	6

Two condensers and air pumps, the latter direct action. One boiler, same size as that for the West Wind. Fan blast to be used. Hull by Birely & Son.

Length on Deck,	160 ft.
Breadth of Beam,	25
Depth of Hold,	9

Also for R. F. Loper, Esq., one sett of Engines and Boilers, the same as building for the Wm. Penn. Hull by Williams & Hoover, of Gloucester, N. J.

Length on Deck,	155 ft.
Breadth of Beam,	26
Depth of Hold,	16

Also for Mail Boat from Vera Cruz to the Amazon River.

Two Direct Action Engines.

Diameter of Cylinders,	1 ft.	8 in.
Length of Stroke,	1	2
Diameter of Propeller,	6	
Pitch at Centre of Pressure,	13	

One Condenser and two direct action Air Pumps with Canvass Valves. One Boiler, 12 feet long, 5 feet 6 inches wide, and 6 feet 9 inches high. Two Furnaces with grates 4 feet 9 inches long· the flame passes through 2 arches, and returns through tubes. Chimney 2 feet diameter, and 20 feet high above grate; anthracite coal with fan blast to be used, Hull, by Birely & Son.

Length on Deck,	85 feet.
Breadth of Beam,	16 “
Depth of Hold,	7 “

Also a Steamer Tug, for the Harbor of San Francisco.

Two Vertical Direct Action Engines.

Diameter of Cylinders,	1 ft.	10 in.
Length of Stroke,	1	8

One Condenser with two direct action Air Pumps.

Diameter of Propeller,	7	6
Pitch at Centre of Pressure,	15	8

One Boiler 21 feet long, with a front and shell of 6 feet; one Furnace with grate 5 feet long, four lower flues, and fourteen return flues, the latter 6 inches diameter. Chimney, 25 feet high above grate, and 2 feet 3 inches diameter. Hull by Wm. Cramp, Kensington.

Length on Deck,	86 feet.
Breadth of Beam,	19 "
Depth of Hold,	8 "

Messrs. I. P. Morris & Co., of the Richmond Iron Works, have in hand, the machinery of the Boston Steamer, *Benjamin Franklin.*

Two Vertical Direct Action Engines.

Diameter of Cylinders,	3 ft.	4 in.
Length of Stroke,	2	10
Diameter of Propeller,	11	4
Pitch "	35	2
Number of Blades,	4	
Length of Blade on the Angle,	6	6

There are two Air Pumps and condensers, the former are direct action, and worked by links from cylinder cross heads. There are two vertical tubular boilers, 19 feet long, 9 feet 3 inches wide, and 10 feet high; each has two furnaces with grates 7 feet long. The engines are connected at rightangles, and the Propeller is attached to the crank shaft without geering; Hull by Birely & Son.

Length on Deck,	180 feet.
Breadth of Beam,	26 "
Depth of Hold,	19½ "

Messrs. J. T. Sutton & Co., of the Franklin Iron Works, have in hands for the Steamer Samuel S. Lewis, to run from Boston to Liverpool, two condensing steam engines with cylinders at an angle of 45°. The crank shaft of the engines being directly over the propeller shaft, with the cylinders below.

Diameter of Cylinders,	5 feet.	
Length of Stroke,	3 "	4 in.
Diameter of Propeller,	14 "	
Number of Blades,	4	

The propeller is geered from the engine shaft, so that while the latter makes 1, the former makes 1¾ revolutions. The large spur wheel is 8 feet diameter, and 3 feet 6 inches face, having several setts of wooden teeth, so arranged as to divide the pitch. There are two boilers, and Anthracite Coal with fan blasts is to be used. The hull of this vessel was built by Birely & Son.

Length on Deck,	225 feet.
Breadth of Beam,	32 "
Depth of Hold,	27 "

They are also building two trunk engines for a large steamer tug to be used on the Delaware, for towing to the Capes.

Area of Cylinders equal to a clear diameter of	2 ft.	8 in.
Length of Stroke,	2 "	6 "

With a single propeller, and one boiler; hull building by Vaughan & Lynn.

Length on Deck,	135 feet.
Breadth of Beam,	25 "
Depth of Hold,	12 "

Messrs. Vaughan & Fisher, are building the hulls of two propeller steamers that are reported as being intended to run from this City to New York, outside.

Length on Deck,	130 feet.
Breadth of Beam,	22 "
Depth of Hold,	9 "

The machinery for these vessels is being erected by Messrs. Hogg & Delamater, of New York, and consists of two engines for each, with cylinders over cranks.

Diameter of Cylinders,	2 ft. 2 in.
Length of Stroke,	2 " 2 "
Diameter of Propeller,	9 "

There is but one condenser and air pump to each pair of engines. The pump shaft is worked by a rod connected to the forward crank, any the air pump, which is set within the condenser, is at the side midwad between the two cylinders. There is one boiler to each vessel with a round shell, 8 feet diameter, 24 feet long, and the fuel is to be Anthracite coal with fan blasts. B.

FRANKLIN INSTITUTE.

Proceedings of the Stated Monthly Meeting, August 21, 1851.

S. V. Merrick, President, in the chair.

Isaac B. Garrigues, Recording Secretary.

The minutes of the last meeting were read and approved.

Letters were read from The Royal Institution of British Architects, and Petty Vaughan, Esq., London; The Smithsonian Institution, Washington, D. C., and John W. Griffith, Esq., City of New York.

Donations were received from The Royal Astronomical Society, The Royal Institution of Great Britain, and The Statistical Society, London; The South Carolina Institute for the Promotion of Art, Mechanical Ingenuity, and Industry, Charleston, S. C.; The Smithsonian Institution, Washington City, D. C.; Professor E. N. Horsford, Cambridge, Massachusetts; John W. Griffith, Esq., and G. P. Putnam, Esq., City of New York; and Richard C. Taylor, Esq., and B. H. Bartol, Esq., Philadelphia.

The Periodicals received in exchange for the Journal of the Institute were laid on the table.

The Treasurer's statement of the receipts and payments for the month of July was read.

The Board of Managers and the Standing Committees reported their minutes.

New candidates for membership in the Institute (6) were proposed, and the candidates (3) proposed at the last meeting were duly elected.

JOURNAL

OF

THE FRANKLIN INSTITUTE

OF THE STATE OF PENNSYLVANIA

FOR THE

PROMOTION OF THE MECHANIC ARTS.

OCTOBER, 1851.

CIVIL ENGINEERING.

On the Asphalted Macadamised Roads lately laid down in Paris. Compiled from 'Les Annales des Ponts et Chaussées, 1850.' By M. De Coulaine, *Engineer of the 'Ponts et Chaussées.'**

Chapter I.

The first applications of bituminous substances to roadways were made in Paris, on la Place Louis XV.,—opposite to the Church of St. Roch, and at the extremities of several streets on the Boulevards. In these essays, blocks 6 inches thick, formed of fragments of quartz, in a bituminous mastic, with a base of coal tar, were placed on a bed of sand; spaces from $1\frac{1}{4}$ to $1\frac{1}{2}$ inches wide, were left between them, which were subsequently filled in with the mastic.

The results obtained were far from being such as had been anticipated. The bitumen made with the coal tar (which is friable, especially at a low temperature,) was very soon pulverized; the stones became detached; and the paving, at first exceedingly even, shortly became as rough as the very worst paving upon the old systems.

Other trials were made, in which a kind of concrete, with a base of coal tar bitumen, was employed: the success was not greater than before.

The principal defect of these systems consisted in the use of the coal tar. A bituminous mastic, in order to be able to resist the continuous action of carriage traffic, should preserve, even during the hardest frosts, a malleability which will allow it to alter its form without breaking, instead of being hard and brittle. In the first essays, hardness was the only quality sought for, whilst ductility, or suppleness, should have been the object. Starting, therefore, upon principles diametrically opposite, it is not to be wondered at that such different results should have been obtained as those about to be mentioned.

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* From the London Civil Engineer and Architect's Journal, for March 1851.

Before describing the experiments made on the subject, it is indispensable to enter into some preliminary details upon the nature, properties, and composition of bituminous matters.

CHAPTER II.—COMPOSITION AND PROPERTIES OF BITUMINOUS MATTERS.

Composition of Bituminous Mastics.—These mastics are principally composed of bitumen, or mineral tar, and of limestone. In the greater number of cases in which it is applied, a sharp sand is added to these two substances. But the choice of the bitumen and the limestone are the only really important parts of the operation: their qualities should be as follows:

Composition, Qualities, and Properties of the Bitumen.—The bitumens, or mineral tars, belong to the class of mineral combustibles. At the ordinary temperature of the atmosphere, they are sometimes dry and brittle; at others, soft, viscous, or even liquid. In the intermediate state, they spread and flow slowly; they may be observed to yield progressively to the weight of any superincumbent body; whilst a weight even much heavier, if thrown suddenly on their surface, bounds off again without leaving even a sensible trace. They contract very sensibly under great colds. They melt at a point a little above 212° Fah. Between 250° and 290°, they give off dense smoke, and begin to boil. The product of the distillation is an oil, the properties of which vary according to the nature of the tar. In proportion as the distillation advances, the liquidity and elasticity of the bitumen diminishes. When, at length, all the vapors have passed off, nothing is left but a black substance, brittle at ordinary temperatures, shiny, and which, by the application of a prolonged heat, decomposes with the greatest facility. Operating synthetically, and placing in contact the two elements which have been thus separated by heat, they recombine, and reproduce a bitumen similar to the one operated upon.

The mineral tars, then, are composed in a similar manner to fatty substances, and contain two principles analagous to the *stearine* and *olein* of the latter. And it is from this composition, hitherto apparently unnoticed, that all the properties of the bitumens are derived, as are also those of the mastics, into the composition of which they enter. Hitherto, no explanation has been offered of the differences to be observed in them: it would appear to result from the nature of the oils they contain.

Thus, the oil which coal tar contains possesses a very disagreeable odor, similar to that of the tar itself. Perfectly limpid and colorless when freshly distilled, it discolors and carbonises upon contact with the atmosphere. It is excessively volatile, even at the ordinary temperature. Thence it is that the coal tar dries with great rapidity, and produces very brittle mastics. It is useless to endeavor to obtain a sufficient consistence by regulating the intensity of the fire; this consistence becomes promptly altered by the spontaneous evaporation of the oil above mentioned.

The Bastenne bitumen, on the contrary, contains an oil much less volatile—one which is more persistent in its character, and which does not evaporate sensibly in the open air. By conforming, therefore, to the prescriptions indicated in the following part of this notice, very excellent bituminous mastics are prepared from it.

It is possible to communicate to the coal tar a portion of the qualities of the Bastenne bitumen, by concentrating it sufficiently, and replacing the oil which has evaporated by a more fixed oil. Some footpaths executed with bitumen thus prepared, have succeeded tolerably well. But it has been found very difficult to effect perfectly the substitution alluded to. It has, in fact, been noticed that when the distillation approached its termination, the bitumen decomposed. It becomes, then, necessary not to carry this operation to the extreme, and the consequence is, that the mastic, obtained in this manner, contains some volatile oil. If the substitution were complete, the price would be found to be at least equal to that of the Bastenne bitumen, such as is met with in commerce.

Composition and Qualities of the Limestones.—The limestones which enter into the composition of the bituminous mastics are of two sorts—1. The limestones, properly so called. 2. The natural asphaltes, or the bituminous limestones.

The limestones, properly so called, should be pure, or at least contain as small a portion as possible of foreign substances. Inasmuch as sulphur renders the mastics brittle, such stones as contain it should be rejected. In order that the limestone may easily combine with the bitumen, it is indispensable that it should be reduced to an impalpable powder. Unslaked lime has been employed, in a ground state, with perfect success.

The bituminous limestones hitherto employed have been the asphaltes of Seyssel, Val-de-Travers, and of Lobsann; they are principally composed of a carbonate of lime and a bitumen completely identical with that of Bastenne. These two elements are generally combined in the proportions of nine parts of the carbonate of lime to one of bitumen.

Before submitting the asphalte to fusion in combination with the bitumen, it is indispensable to reduce it to a fine powder, either by some mechanical means, or by action of the heat, which causes it to decrepitate and fall to dust. In this state it enters rapidly into combination with the bitumen.

The pure limestones, however, required a prolonged heat before they enter into combination, and this is susceptible of altering the qualities of the mastic. Moreover, it is to be feared that the combination of the bitumen and of the limestone should not be so intimate as that of the former with the asphalte, and that the mastic should not present the degree of homogeneity required. As the use of limestones does not offer any appreciable economy, it appears that no hesitation should be felt in giving the preference to the natural asphaltes.

Resuming, then, what has been above stated, the two substances which ought to form the base of the composition of bituminous mastics are—first, the Bastenne Bitumen; secondly, the Calcareous Asphaltes.

Qualities of the Sand.—As to the sharp sands added in most cases, the only important condition they are required to fulfil is, that they be exempt from any earthy matters.

CHAPTER III.—PREPARATION AND MODE OF USE OF THE BITUMINOUS MASTICS INTENDED FOR THE MAKING OF ROADS, OR OF FOOTPATHS.

Having thus exposed the principles which affect the chemical application of the materials, it is proposed to explain the methods followed in preparing the mastics for roadways.

Proportions of the Materials used.—The substances described previously, when employed with the necessary precautions, answer perfectly, so long as it is only required to form ordinary footpaths. For carriageways it is, however, necessary to introduce some modifications; for instance, an essential oil is required to be added in order to give the mastic all the malleability and the suppleness required.

The oil employed by M. de Coulaine is the oil of resin. Any other fat oil, not exposed to the inconvenience of drying, may be substituted for this; but their odor is generally disagreeable, and their price usually more elevated.

The materials thus mentioned should be employed in the following proportions, in weight avoirdupois:—

Bastenne Bitumen, ...	16·875 lb.
Asphalte of Seyssel, ...	225·000
Oil of Resin, ...	6·250
Sand, ...	135·000

Melting.—The above materials are successively introduced into the cauldrons in which the melting is to be effected. The bitumen is melted first, the asphalte is then to be added in small portions. When the pulverisation of the latter is effected by heat, it is preferable to carry on the two operations simultaneously, and to pour the asphalte into the cauldron whilst it is still warm. A portion of the bitumen is thus saved, the expense of fuel is much diminished, and the preparation of the mastic is carried on more rapidly. Lastly, when the asphalte is completely dissolved in the bitumen, the oil and the sand are to be added. During the whole of this operation it is indispensable to stir the materials continually, in order that the combination may be perfect, and that the mastic which touches the sides of the cauldron may not be burnt.

The termination of the operation is announced by the rising of steam bubbles to the surface, which explode there and give off a bluish flame. It then becomes important to verify if the mastic has a proper degree of concentration.

We have indeed seen that the bitumen loses its elasticity progressively, in proportion as it loses by evaporation a part of the oil it contains. The same thing occurs with the mastic; the consistence it is likely to take on cooling does not only depend on the proportions of the materials employed, but also on the composition of the bitumen and the asphalte, as well as upon the duration and intensity of the heat they are exposed to.

Now the actual state of the material in this stage of the process affords but little indication of this consistence; for, at a high degree of temperature, the two elements of which the mastics are formed give them the same liquidity. Thus, a cauldron of material, thick and difficult to stir, because it does not contain a sufficient quantity of bituminous matters, would, nevertheless, yield a product which would be very soft if the proportion of oil were too great; whilst the most fluid mastic, on the other hand, may become brittle when the other element is in excess. It is, indeed, easily conceivable that both these cases should frequently occur in practice. Suppose, for instance, that the bitumen employed is very soft, that is to say, that it contains a large quantity of oil, it will be necessary to evaporate the greater part of this oil, and the matter, perhaps, will become too thick to be employed before it can obtain, by cooling, a sufficient degree of firmness. The opposite effect would occur if the bitumen were too much concentrated.

The duration of the melting cannot either be taken as a rule; for the intensity of the fire, the exterior temperature, the strength of the wind, all exercise a great influence on its results.

Nevertheless, it is indispensable to ascertain whether the asphaltic mastic fulfils the requisite conditions, and that after it has been employed it will not present either an excess of hardness, which should lead to its being crushed, nor an excess of softness, which should lead to deformations and increase the draught. The workman who applies the mastic can judge whether it is of a proper degree of fluidity at the moment when he pours it out; but, as we have said, he cannot, from that indication, predicate the degree of consistence it will attain when it cools. The following method of ascertaining the latter condition has been adopted.

Preliminary Trial of the Mastic.—The workman entrusted with the superintendence of the cauldrons, pours a small sample of the mastic, about three inches long by two inches wide, and half an inch thick, upon a wrought iron plate, whose ends are turned up all round. He then moves this sample about in water maintained at 77° Fah., until it has attained the same temperature, and it is then tried in the following manner:—

He takes a small board, upon which are fixed two steel points, having the form of quadrangular pyramids, whose height equals the side of the base. He places one of the points on the sample to be tried, and the other on a similar sample previously prepared, of the degree of consistency required and maintained at the same degree of temperature. He stands upon the board, and with his whole weight gives it a slight movement to and fro, so as to cause the points to enter into the two samples. To indicate that the melting has been carried to the proper degree it is evidently necessary that the two points should enter in a similar manner. This, of course, can be ascertained precisely, by measuring the side of the impressions, whose depths will, of course, be precisely the same, owing to the form of the points described above.

From many experiments made upon this subject, it appears that, the weight of the workman being usually from 140 lbs. to 160 lbs., avoirdupois, the side of the impression should be about three inches when the mastic is to be used for roads. For covering arches, terraces, &c., it should be about two and a half inches; for foot paving, or similar external works, it should be about two inches. In the latter case the addition of the oil of resin ceases to be necessary, unless the melting should have been too much prolonged.

When the width of the impression is less than two inches, the mastic, which shrinks in cold weather more than the substances it is combined with, does not possess sufficient elasticity to allow that movement to be carried on freely. It tears asunder, and principally in the direction of the soldered joints.

The above indications only refer to the climate of France. It is evident that they must be modified for countries in which the climate might be different.

If the width of the impression be less than the dimensions given above, oil is to be added, and well mixed with the contents of the cauldron, and experiments are made successively until the proper degree of consistence is attained. If the oil should have rendered the mastic too liquid, a certain quantity of asphalte or of sand should be added. When, on the contrary, the width exceeds those dimensions, the boiling should be continued until the mastic becomes sufficiently concentrated. If, during this operation, it should happen to become too thick, a quantity of bitumen should be added, sufficient to bring it to a condition such as would allow of its being easily spread. Care must, however, be taken not to render it too liquid, because an excess of that quality would give rise to the double inconvenience of rendering the work executed with it too soft in summer, and too hard and brittle in winter. Indeed, to prevent the bituminous mastics from exercising different actions in different conditions of temperature, it is necessary, not only that they should satisfy certain conditions at one particular degree, but that they should be able to do so at any other (at that which corresponds with their fusion point for instance); and it is evident that the nearer the last may approach the first, the less the mastics are likely to be affected by alternations of heat or cold, because it is a proof that they contain a greater proportion of the element which always retains its fluidity. However, when the impression has reached the precise dimensions above indicated, the fire must be removed, in order that the mastic may not become more concentrated, and the application is to be at once commenced.

Too much attention cannot be paid to this mode of proof, which M. de Coulaine regards as being even more important than the choice of the materials.

Mode of Employing the Mastic.—This operation, as far as ordinary footpaths are concerned, is executed in widths of such a size as to allow a man to reach from side to side without touching either edge; that is to say, about two feet six inches.

The material is laid between two wooden gauges, for the first width; their height being regulated by the depth proposed to be given to the mastic. The material is spread by a species of iron trowel, and levelled by means of a rule, resting upon the two gauges in the first width, and on the external gauge and the finished paving for the remainder.

As the levelling of the mastic proceeds, another workman sprinkles sand over the surface by means of a sieve. When he has thus covered about two feet six inches in lengh, he should bring the superabundant sand, by means of a very supple brush, upon the part which has hitherto received none, and with a double-handled rammer he should strike flatly upon the whole surface, so as to force the gravel to enter into the mastic and combine with it. This operation is intended to force the bitumen upon the surface prepared for its reception. It should be done quickly, and by the same man, who also, as soon as it is finished, should strike a series of light blows with an iron hammer upon the still warm material, on the line of its junction with the matter last placed, so as to solder the two edges together in a perfectly solid manner.

In the first trials which were made, under the direction of M. de Coulaine, he introduced small pebbles into the bituminous layer at the moment of its application: but subsequently he abandoned the practice. For he found that whatever the hardness of the stones might be, all of them became crushed under the direct action of the traffic, and that the bitumen was partly brought over them. This action occurred inevitably, because the stones received the whole weight, and they were too small to be able to resist its action. So far, then, from adding to the solidity of the roadway, they only served to diminish it, by forming, on its surface, series of little holes which facilitated its rupture; which were a cause of infiltrations; and upon the edges of which the mastic became detached into thin layers, and finally came off in flakes.

CHAPTER IV.—PREPARATION OF THE FOUNDATION DESTINED TO RECEIVE THE BITUMINOUS MASTICS.

An ordinary broken stone road, solidified and proved by the ordinary traffic, is at the same time the easiest and the most economical in its construction of any such foundation. The concrete employed hitherto, in the general applications, cannot be considered as offering sufficient guarantees. Indeed, concrete must require a sufficient interval of time between its execution and the time of use, to attain its ultimate strength; and even then, its solidity can hardly be comparable with that of a good macadamised road. To prove this assertion, it is only necessary to allow the road traffic to pass over even the very best description of concrete, and it will be found to fall to pieces almost immediately. M. de Coulaine states that he tried a piece of road thus executed in concrete, in which none but the best hydraulic lime was used, and, although it had been executed more than a year before it was delivered to public traffic, it became quickly upset, and it was found necessary to cover it with a thick coat of ordinary stone. In spite of this repair, the roadway appeared always to suffer from the original defect of its formation. Nor can this result be a matter of surprise, if we reflect on the mode of aggregation of the materials in the two respective cases.

Indeed, in a roadway, the aggregation of the materials is effected by compression in such a manner, that when the roadway has become perfectly hard, the stones are, as it were, wedged together, and only hold the quantity of detritus necessary to fill exactly the interstices. It is easily conceivable that the traffic should have little effect on a similar road; and even that, under some circumstances, it should only serve to add to its solidity.

With concrete, on the other hand, the stones do not generally touch one another: they are bound together by mortar, which having but a trifling hardness, and being also devoid of elasticity, is promptly destroyed by the action of the rolling carriages. If even the stones should be as closely agglomerated as in a roadway, the mortar which binds them together and fills their interstices, contains too many calcareous substances to form the kind of detritus able to produce a resisting roadway.

Concrete has another radical defect—namely, that of swelling with frost, should it not be completely dry, or should it be cut up by the traffic. It follows from this, that the bituminous layer which is thus raised by the concrete, is easily broken when a thaw sets in. The unslaked particles of lime produce, by the commencement of that action after the concrete is in its definite position, bubbles, or elevations, of considerable size in the paving which covers them. These disadvantages are of serious moment, even when a common paving is only concerned: in a roadway they would be vital. M. Coulaine observes, that he is far from asserting that a perfectly executed bed of concrete may not succeed; but if a good macadamised road be preferable, why employ a more doubtful and more expensive process?

The reasons above given, led M. de Coulaine to abandon the use of concrete, even for foot-pavings, and to replace it by a layer of broken stones two inches thick, compressed and sanded. This has been invariably found to be successful; and in such cases, the swelling up so often observed against the curb in ordinary bituminous paving, does not occur. Independently of this advantage, there is a notable economy; and the bituminous mastic can be applied in winter as in summer, immediately after the broken stone has been laid down.

When it is required to cover a road for the purpose of carriage traffic, the course to be pursued is as follows:—

A macadamised roadway of broken stone is to be formed of such materials as are not likely to furnish a detritus of a nature to expand by the action of frost; this must be consolidated to an extent sufficient to support any kind of traffic; in fact, a perfect macadamised road must be formed, in any of the usual manners employed, either by the use of the cylinder, or by allowing the road materials to be consolidated by the traffic. If a good roadway already exist, composed of materials little subject to the action of frost, it may be used. As an additional precaution, and to regularise its surface, it is, however, advisable to cover it with a layer of materials about two inches thick, which must be well compressed.

CHAPTER V.—DIMENSIONS TO BE GIVEN TO BITUMINOUS ROADWAYS.—SEASONS IN WHICH THEY SHOULD BE EXECUTED.

Thickness of the Roadways.—The system of foundation, above recommended, allows the thickness of the bituminous coating to be considerably diminished. In some cases it has not exceeded $\frac{3}{4}$ of an inch —that is to say, not more than is usually employed for a foot-path—without any inconvenience being experienced. A thickness of $1\frac{1}{4}$ to $1\frac{5}{8}$ of an inch, gradually increasing from the sides towards the middle, appears then to be perfectly satisfactory, and all that is required for the purpose. The adoption of a greater thickness would but augment the expense without adding to the solidity; it would augment also the difficulties of laying or repairing gas pipes, &c.; and, moreover, would present a greater mass of material liable to be acted upon by the heat of summer.

For the same reason, the rounding of the transverse section should be as small as possible; and it should never exceed more than $\frac{1}{100}$th of the width of the road.

Seasons in which the Bituminous Roadways should be Executed.—Lastly, in addition to the above conditions, there is another very important one to be observed. In order to obtain satisfactory results, it is almost indispensable that the materials be applied in fine weather; when in cold weather, a surface, which can never be entirely exempt from moisture, is operated upon, little interstices are found between the foundation and the mastic, owing to the presence of the aqueous vapors. Now, the bitumen does not retain, at a low temperature, a sufficient degree of elasticity to allow of its filling these little interstices, and bearing exactly upon the subjacent surface, without some rupture being produced by the traffic. It is also to be feared that some parts of the macadamised substratum may not have become solidified, and that accidents may arise from this cause. During the warm weather, however, the bituminous coating adapts itself, without breaking, to the foundation under the pressure of the wheels of the passing traffic; it follows, also, without breaking any subsidence which the foundation may be exposed to. The latter has thus time to become consolidated in those parts where such an operation may be necessary; and when winter arrives, it has thus attained a sufficient degree of hardness to remove any fear of similar accidents.

It would be advisable to limit the time for using the bituminous mastics to the period between May and September. A previously executed roadway of this material may be excepted, for that may be repaired at any time.

Such are the conditions which M. de Coulaine, who has already had considerable experience in the use of this material, considers to be indispensable to insure the success of the application of the bituminous mastics. By observing them scrupulously, there appears to be little doubt of obtaining successful results.

CHAPTER VI.—ACCOUNT OF WORKS EXECUTED.—ROADWAY AND IMPERMEABLE COVERING TO THE ARCHES OF THE BRIDGE OVER THE LOIRE AT SAUMUR.—PRECAUTIONS TO BE TAKEN IN EXECUTING SUCH COVERINGS.

The first essay of a roadway in bitumen executed by M. de Coulaine was executed upon a macadamised road joining the paving of the national road from Bordeaux to Rouen. The surface of this road was picked over, then covered with a layer of stones 2 inches thick, and compressed by a roller of 10 tons weight. This operation was performed in order to obtain a surface perfectly hard and even.

In different portions the thickness of the bituminous coating was varied, as were also the proportions of the asphalte and of the sand. Small pebbles were, moreover, placed by hand in the asphalte, at the moment of its being employed.

This essay was made upon a length of 66 feet, and a width of 13 feet.

The average number of collars traversing it (or of draught horses pulling from a collar) was 150; the number being taken between six in the morning and six at night. It was opened to traffic on October 6, 1840.

In March 1849, the only remarkable decay had taken place in the portions executed with a thickness of about $\frac{3}{4}$ inch to 1 inch, or in those which contained an excess of sand. All the other portions have resisted well during the nine years they have been exposed to wear. Nevertheless, the stones which projected, and were very close together, became all crushed, but the space they left was filled gradually by the bitumen adjoining, and it alone now appears upon the surface. It is principally to this defective execution, namely, the introdction of the small stones, that the few inequalities to be observed are owing. It is also necessary to add that the mastic had not been submitted to the trial above indicated.

Guided by the information obtained from the experience of these first essays, other applications were made elsewhere on a larger scale, avoiding successively the defects which were found to exist; and the last applications, especially, have produced the most satisfactory results.

The covering of the arches of the great bridge over the Loire, at Saumur, may be mentioned first. It is about 920 feet long by 25 ft. 3 in. wide. The thickness of the bituminous coating was made $1\frac{5}{8}$ inches. The macadamised foundation was laid upon the bed of the old paving, and it has a thickness of 4 inches. The first parts of this roadway were under constant use from September 1841, to March 1849, and retained their form perfectly.

During warm weather the wheels form slight ruts, but these marks are soon mutually effaced by the action of the traffic; and they disappear altogether when the temperature becomes lowered. If a carriage, instead of being in movement, remain long upon the road in the same place, it leaves a more perceptible mark, attaining sometimes a very considerable depth. This is the deeper in proportion as the time of stationing is prolonged, and also to the heat of the weather; but it also disappears, however deep, under the effect of the traffic. In ordinary weather, and under ordinary circumstances, the heaviest loads hardly leave a perceptible trace; and yet the roadway preserves, during the most severe frost, an elasticity which prevents its breaking or falling to pieces in any manner; the feet of horses alone appear to detach some fragments. All the effect produced by traffic seems, then, to be merely to alter the form. The result is, that notwithstanding the small amount of hardness of the roadway, it wears away very slowly.

Some deformations took place where the mastic had been used in too fluid a state; but only in those where the proof already mentioned had not been applied.

The twelve arches upon which this roadway was laid, have become perfectly water-tight: before its execution they were all, more or less, permeable, although they had been covered with a coating of hydraulic lime, executed with the greatest care. We know, indeed, that coatings of this nature do not preserve arches effectually from moisture, but in certain conditions—when, for instance, transverse or longitudinal inclinations afford free passage to the waters. If this condition be not fulfilled, the slightest crevice gives rise to filtrations. But when the centres of any large arch are removed, there always occur fissures, of a greater or less degree of importance, at the springing of the arches. This action is aggravated by the alternations of heat and cold, which successively open and close these fissures, and which would also inevitably produce them if they did not previously exist.

The bridge at Saumur is precisely under these conditions. The covering is horizontal, the span of the arches is 66 feet, and during the extremes of temperature it is easy to perceive the alternate movements above-mentioned. The bituminous mastics, on account of their natural elasticity, generally resist their action. Nevertheless, it is to be feared that this would not always be the case if the roadway were immediately laid upon the masonry; and it would be prudent to interpose another body, such as a bed of sand, covered by a coating of macadam about 2 inches thick, so as to prevent the movements of contraction and dilation from affecting the mastic.

From what has been just said, it is easily to be understood that the covering of the bridge at Saumur, by a roadway in bitumen, should, at the same time, render it perfectly water-tight; and it was principally with this view that the work was executed. By its inclinations, and open gutters,—by its entire independence of the masonry, as much as by its natural impermeability, it assures the perfect dryness of the arches: and as the fissures which may exist upon its surface, by their becoming visible during wet weather, can be easily visited and repaired, this kind of covering for arches has an advantage which the ordinary ones, covered by a paving themselves, can never possess; and, moreover, as the bituminous roadways obviate the shocks to which the masonry is exposed from the traffic, they present, on that account alone, a great recommendation.

Precautions to be taken generally in Covering Arches.—In order to ensure in all cases a perfect union of the mastic with the footways, parapets, or walls, and to hinder the filtrations which might take place at their junctions, it will be necessary to cut a groove, of about 2 inches deep horizontally, and extending an inch both above and below the asphalte vertically, so as to form a tongue. To render the union more perfect, the sides of the groove should be covered with liquid bitumen, applied hot; and it should be filled with the mastic at the same time as the paving is executed, taking care to fill in the corner with a species of inclined plane

When it is required to cover a new building, it is preferable to carry the coating over the whole surface of the construction, and consequently to carry it under the walls and parapets which are intended to surround the terrace; or to continue the mastic up the inside or over the top of the walls, according to the circumstances of the case. Any masonry, with its joints, or artificial rendering, is far from impermeable; and it is on account of having neglected the precautions above indicated, that, under many cases, humidity has entered into buildings covered by bitumen.

In such parts as are intended to support any superincumbent masonry, small blocks must be introduced to prevent the bitumen from being squeezed out.

Other Essays.—A part of the road from Briare to Anger was also covered in bitumen for a length of about 560 feet, by 20 feet wide. It had resisted perfectly from the commencement of 1842 to March 1849. Its thickness was 1¼ inch, but in places it was safely reduced to ¾ inch.

A portion, about 50 feet long by 40 feet wide, of the road over the bridge at Tours, on the route from Paris to Bayonne, was laid down in May 1842. It had resisted, up to 1849, a daily circulation of 800 collars, and the arch had become perfectly dry.

The crossing at the end of la Rue Laffite, on the Boulevard, may also be cited. It is situated in one of the most frequented parts of that busy part of Paris, and is traversed by not less than from 3000 to 4000 collars per day. It was executed with a thickness of not less than 2¼ inches, upon a previously existing, but then ruined, pavement in bitumen. Notwithstanding the great passage and thoroughfare upon it, this sample has stood perfectly for more than six years.

If this piece of asphalted road be compared with any specimen of stone paving, however carefully executed in the materials usually employed at Paris, the superiority of the pavement in bitumen at the end of la Rue Laffite must be evident.

(To be Continued.)

Specification of the Patent granted to Edward Dunn,* *for an Improved Engine for Producing Motive Power by the Dilatation or Expansion of certain Fluids or Gases caused by the application of Caloric.*—Sealed 26th December, 1850; Enrolled June 26, 1851.†

The invention consists in producing motive power by the application of caloric to atmospheric air or other permanent gases or fluids susceptible of considerable expansion by the increase of temperature,—the mode of applying the caloric being such, that after having caused the expansion or dilatation which produces the motive power, the caloric is transferred to certain metallic substances, and again re-transferred from these substances to the acting medium at certain intervals, or at each successive stroke of the motive engine; the principal supply of caloric being thereby rendered independent of combustion or consumption of fuel accordingly, whilst in the steam engine, the caloric is constantly wasted by being passed into the condenser, or by being carried off into the atmosphere. In the improved engine, the caloric is employed over and over again, enabling me to dispense with the employment of combustibles, excepting for the purpose of restoring the heat lost by the expansion of the acting medium, and that lost by radiation also, for the purpose of making good the small deficiency unavoidable in the transfer of the caloric.

Having thus stated the object and general character, I will now proceed to describe the structure of the improved engine for producing motive power, reference being had to the drawing.

Figs. 1 and 2 represent longitudinal sections of the engine, both being alike in all essential points, differing only in part of the detail, as will be clearly seen by the following description:—

I will first describe fig. 1. A and B, are two cylinders of unequal diameter, accurately bored and provided with pistons, *a* and *b*, the latter having air-tight metallic packing-rings inserted at their circumferences. I call A, the supply cylinder, and B, the working cylinder. a^1, piston-rod attached to the piston, *a*, working through a stuffing-box in the cover of the supply cylinder. C, is a cylinder with a spherical bottom attached to the bottom of the working cylinder at *c*, *c*. I call this vessel the expansion heater. D, D, rods, or braces, connecting together the supply piston, *a*, and the working piston, *b*. E, is a self-acting valve, opening inwards to the supply cylinder. F, a similar valve, opening outwards from said cylinder, and contained within the valve-box, f^1. G, is a cylindrical vessel, which I call the receiver, connected to the valve-box, *f*, by means of the pipe g^2. H, a cylindrical vessel, with an inverted spherical bottom. I call this vessel the heater. J, a conical valve, supported by the valve stem, *j*, and working in the valve chamber, J^1, which chamber also forms a communication between the expansion heater, C, and heater, H, by means of the passage, *h*. K, is another conical valve, supported by the hollow valve stem, *k*, and contained within the valve chamber, k^1. L, and M, two vessels of cubical form, filled to their utmost capacity, excepting small spaces at top and bottom, with disks of wire —net or straight wires—closely packed, or with other small metallic substances, or mineral substances, such as asbestos, so arranged as to have minute channels running up and down. I call these vessels, L, and M, with their contents, regenerators. *l*, *l*, *m*, *m*, pipes, forming a direct communication between the receiver, G, and the heater, H, through the regene-

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* Agent for John Erricsson, of the United States.

† From the London Repertory of Patent Inventions, for August, 1851.

Fig. 1.

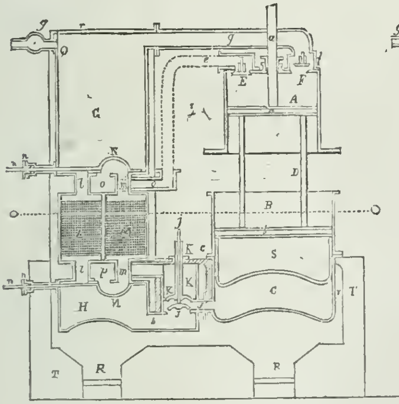


Fig. 2.

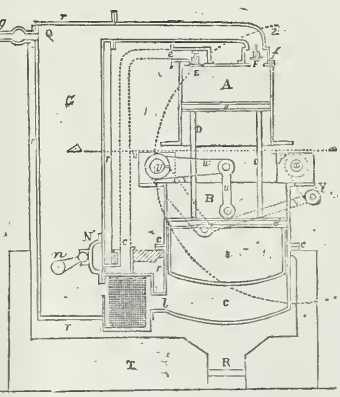


Fig. 3.

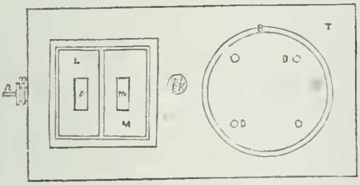
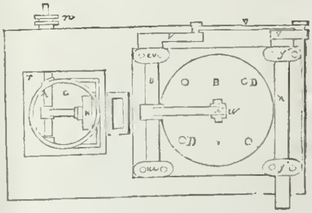


Fig. 4.



rators. N, N, two ordinary slide valves, arranged to form alternate communications between the pipes, *l*, *l*, *m*, *m*, and the exhaust chambers, O, and P, on the principle of the valves of ordinary high pressure steam engines. *n*, *n*, valves, stems working through stuffing-boxes. n^1, n^1, *p*, pipe communicating between the valve chamber k^1, and exhaust chamber, P. o^1, pipe leading from exhaust chamber. O, Q, pipe leading into the receiver G, provided with a stop cock, *q*. R, R, fire-places for heating the vessels, H and C. *r*, *r*, *r*, *r*, flues leading from said fire-places, and terminating at r^1. S, a cylindrical vessel attached to the working piston, *b*, having a spherical bottom corresponding to the expansion vessel, C. This vessel, S, which I call the heat intercepting vessel, is to be filled with fire-clay at the bottom, and ashes, charcoal, and other non-conducting substances towards the top: its object being to prevent any intense or injurious heat from reaching the working piston and cylinder. T, T, brickwork, or other fire-proof material, surrounding the fire-places and heaters.

I now proceed to describe fig. 2. All corresponding parts in this figure are marked by similar letters of reference, as in fig. 1. It will, however, be well briefly to repeat the description of the same. A, supply cylinder; *a*, supply piston. B, working cylinder; *b*, working piston. C, expansion heater; *c*, junction of working cylinder and expansion heater. D, connecting the supply and working pistons. E, inlet valve of supply cylinder; *e*, valve chamber of the same. F, outlet valve of supply cylinder, and *f*, its chamber. G, receiver; *g*, pipe connecting the same to outlet valve chamber, *f*. L, regenerator; *l*, passage between the same and receiver; l^1, passage between the regenerator and the expansion heater. N^1, slide valve; *n*, stem or spindle, for working same. O, exhaust chamber under the slide valve; o^1, outlet pipe. Q, pipe leading into receiver; *q*, stop cock in the same. R, fire-place; *r*, *r*, *r*, *r*, flues leading from said fire-place; r^1, exit of said flues. T, brickwork surrounding the fire-place and flue. U, rock shaft, supported at both ends by appropriate pillar blocks; *u*, u^1, crank lever, or arm, attached to the said rock shaft; u^2, link connecting said arm to the working piston, *b*. V, another crank lever, or arm, attached to the extreme end of the rock shaft. *x*, crank shaft, or axle, having a crank, Y, firmly attached. *v*, connecting rod, connecting the arm V, to the crank pin, *y*, of crank Y; y^1, pillar blocks, supporting the crank shaft, *x*. Z, Z, represent the circumference of a fly-wheel, paddle-wheel, propeller, or other rotary instrument to be worked by the engine.

Fig. 3, represents a sectional plan of fig. 1; and

Fig. 4, a sectional plan of fig. 2.

Before describing the operation of the improved engine, it will be proper to observe that the piston rod, a^1, only receives and transmits the differential force of the piston, *b*, viz: the excess of its acting force over the re-acting force of piston, *a*. It will also be proper to observe that this differential force imparted to said piston rod may be communicated to machinery by any of the ordinary means, such as links, connecting rods, and cranks; or it may be transmitted directly for such purposes as pumping or blowing. I have further to observe that the conical valves, K and J, may be worked by any of the ordinary means, such as eccentrics or cams, provided the means adopted be so arranged that the valve, K, will commence to open the instant that the piston, *b*, arrives at the full up-stroke, and be again closed the instant the piston arrives at full down-stroke; whilst the valve J, is made to open at the same moment, and to close shortly before or at the termination of the up-stroke. In like manner the slide valve, N, is to open and close as the piston, *b*, arrives respectively at its up and down stroke, similar to the slide-valve of an ordinary high pressure engine. It will be seen that the link, u'', like the piston-rod, a', only transmits the differential or useful force of the piston, *b*.

Having thus described the construction of the engine, I will now proceed to describe the manner in which the same is to be put into operation, reference being first had to fig. 1. Before starting, fuel is put into the fire-places, R, R, and ignited, a slow combustion being kept up until the heaters and lower parts of the regenerators shall have been brought to a temperature of about 500 degrees. By means of a hand pump, or other similar means, atmospheric air is then to be forced into the receiver, G, through the pipe Q, until there is an internal pressure of some eight or ten pounds to the square inch. The valve, J, is then to be opened, as shown in the drawing; the pressure entering under the piston, *b*, will cause the same to move upwards, and the air contained in A, will be forced through the valve, F, into the receiver. The slide-valves, N, N, being, by means of the two stems *n*, *n*, previously so placed that the passages, *l*, *l*, are open, the air from the receiver will pass through the wires in L, into the heater, H, and further into C, the temperature of the air augmenting, and its volume increasing as it passes through the heated wires and heaters. The smaller volume forced from A, will, in consequence thereof, suffice to fill the larger space in C. Before the piston arrives at the top stroke, the valve J, will be closed, and at the termination of the stroke the valve, K, will be opened; the pressure from below being thus removed, the piston will descend, and the heated air, in C, will pass through k^1, *p*, P, and *m*, into the regenerator, M, and in its passage through the numerous small spaces or cells formed between the wires, part with the caloric, gradually falling in temperature, until it passes off at o^1, nearly deprived of all its caloric. The commencement of the descent of the piston, *a*, will cause the valve, F, to close, and the valve, E, to open, by which a fresh charge of atmospheric air is taken into the cylinder, A. At the termination of the full down-stroke the valve, K, is closed, and the valve, J, again opened, and thus a continued reciprocating motion kept up. It will be evident that, after a certain number of strokes, the temperature of the wires or other matter contained in the regenerators will change, that of M will become gradually increased, and that of L diminished. The position of the slide-valves, N, N, should, therefore, be reversed at the termination of every fifty strokes of the engine, more or less, which may be effected either by hand or by a suitable connexion to the engine. The position being, by either of these means, accordingly reversed to that represented in the drawing, the heated air or other medium passing off from C, will now pass through the partially-cooled wires in L, whilst the cold medium from the receiver will pass through the heated wires of M, and on entering H, will have attained nearly the desired working temperature. In this manner the regenerators will alternately take up and give out caloric, whereby the circulating medium will principally become heated, independently of any combustion, after the engine shall have been once put in motion.

Having thus with special reference to fig. 1, described the manner of putting the improved engine into operation, I have now to notice that the said engine as represented in fig. 2, is operated precisely in the same manner, excepting that the regenerator is arranged in a single vessel, and that the metallic substances therein take up the caloric from the circulating medium that leaves the working cylinder or vessel, c, and returns the same to the circulating medium that enters the working cylinder at each stroke of the engine, instead of transferring and re-transferring the caloric at intervals, as shown in fig. 1. The manner in which the differential or useful upward force of the working piston, *b* (fig. 2), in conjunction with its descending power, caused by gravity, is made to impart rotary movement to the crank-shaft, *x*, becomes self-evident on examining the disposition of the working-gear of the engine, as shown in the drawing. It is particularly worthy of notice that the relative diameter of the supply and working cylinder will depend on the expansibility of the acting medium employed; thus, in using atmospheric air or other permanent gases the difference of the area of the pistons may be nearly as two to one, whilst in using fluids, such as oils, which dilate but slightly, the difference of area should not much exceed one-tenth. I have next to notice that in employing any other medium than atmospheric air, it becomes indispensable to connect the outlet pipe, o^1, and the valve-box, *e*, of the outlet valve, E, as indicated by dotted lines in both figures; these dotted lines representing the requisite connecting pipe. The escaping air or fluid at o^1, will, when such a connecting pipe has been applied, furnish the supply cylinder independently of other external communication, and the acting medium will perform a continuous circuit through the machine under this arrangement, the operation being, in other respects, as before described. It is evident that the several parts composing the improved engine may be arranged in various ways, and that the external form thereof may be greatly changed, whilst its principle of operation remains substantially as I have ascertained and described. It is also evident that the working cylinder may be placed horizontally or otherwise, and that it may be made double acting, and that a heat-intercepting vessel may be applied at each end of the working piston, as also an expansion-heater at each end of the working cylinder. I do not, therefore, confine myself to the exact form represented in the drawing, but I claim as the invention the substantial feature of the devices I have described as new, and by which I secure great and beneficial results; and particularly I claim as the invention:

First, I claim the structure which I call the regenerator, by which I effect a transfer of the caloric contained in the air, or other circulating medium, that passes off from the working cylinder to a series of disks of wire-net or to other minute metallic or mineral substances, for the purpose of being again transferred to the air or other circulating medium that enters the working cylinder, whether said structure be so arranged that the metallic or mineral substances are made to take up and again return the caloric at each successive stroke of the working piston, as in fig. 2, or whether it is so arranged that the transfer and re-transfer of the caloric takes place at intervals, as in fig. 1, or whether said structure is arranged in any other manner for the purpose of accomplishing substantially the purposes hereinbefore mentioned.

Secondly, I claim the combination of the expansion heater with the working cylinder, by which the fall of temperature consequent upon the expansion of the air or other circulating medium during the upward movement of the working piston becomes restored, and by which also the force of the said piston becomes augmented beyond what it would be if the accession of caloric effected by the expansion heater did not take place.

Thirdly, I claim the heat-intercepting vessel attached to the working piston, by which any injuriously high temperature is prevented from reaching the packing of said piston, and by which also the very desirable end is attained of presenting at all times surfaces of uniform high temperature to the acting medium under the working piston.

Fourthly, I claim the inverted position and open ends of the working and supply cylinders, as represented in the drawing.

Fifthly, I claim the direct attachments of the working and supply pistons, by which not only the acting and reacting forces may be uniformly distributed over the area of each piston, but by which also the entire differential power of the working piston is rendered available, less only the friction of the packings.—In witness, &c.

Cost of Railway Bars.[*]

"Mr. Brunel," says *Herapath*, "has lately completed the contract with the Rhymney Iron Works for many thousand tons of rails, at the low figure of five guineas per ton, delivered, for one of the Exeter railways. The rails are to be guaranteed for five years, and one hundred tons to be deposited with the company for that period as security against breakages and failures. Who will not make railways now?"

The Eastern Counties Railway.[†]

The statistical details of this line show that the company "has spent in the formation of its various lines the really gigantic capital of 12,998,207*l.* 2s. 2d., and that it possesses 326 miles of railroad, over which 1,734,390 persons were carried in the six months ending January 4th, 1851. The classification and revenue arising from this one and three-fourths of a million of passengers were as follows:—

	Number.	£	s.	d.
1st Class Passengers, ...	226,714 .	63,386	9	5
2d Class Passengers, ...	801,541 .	83,733	19	1
3d Class Passengers, ...	706,135 .	54,360	10	8

Giving a total amount of 201,480*l.* 19s. 2d.; in addition to which the company received for the carriage of parcels 15,392*l.* 12s. 6d.; goods, including coals, &c., 140,172*l.* 15s.; cattle, 19,818*l.* 14s. 5d.; mails, 8,591*l.* 14s. 1d. Forming, with other minor sources, a revenue of 400,552*l.* for half a year, or an annual income of upwards of 800,000*l.*—an income much larger than that of many a continental state. This was accompanied by an expenditure of 225,347*l.* 17s., distributed as follows: locomotive expenses, 82,587*l.* 13s. 4d.; maintenance of way, 34,871*l.* 5s. 3d.; miscellaneous working expenses, 86,461*l.* 1s. 8d.; rates and taxes, 12,869*l.* 7s. 7d.; Government duty, 8,558*l.* 9s. 2d.; total, 225,347*l.* 17s.: leaving a profit of 175,204*l.* 6s. 11d. on the half-year's work; which balance, nevertheless, was only sufficient to yield a very small dividend available to the original shareholders; but the prospect of a better result is encouraging."

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[*] From the Builder, No. 436.

[†] Ibid, No. 435.

*Bourdon's Patent Pressure Gauges.**

The want of a good gauge for high pressures has long been felt in the engineering world. Mercury gauges are cumbersome, compressed air gauges never to be depended on for keeping in order, and all the varieties depending on pistons and spiral springs get leaky and stick. Mr. Bourdon has devised a plan which seems to possess none of those defects, and has the merit of being simple and portable. The accompanying sketch shows one variety of the improved gauge. Its action depends on the fact that a thin metal tube of such a section as *e* or *g*, if coiled up and subjected to internal pressure, will tend to uncoil itself in proportion to the amount of the pressure.

Fig. 1.

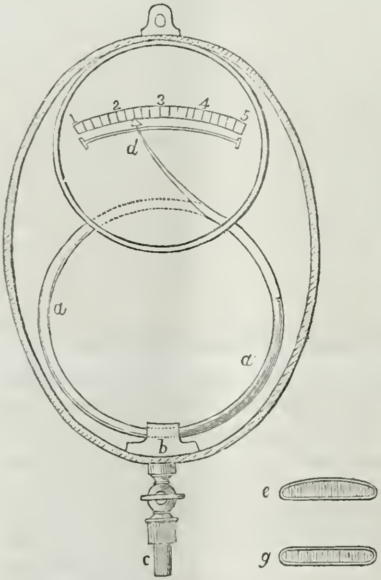
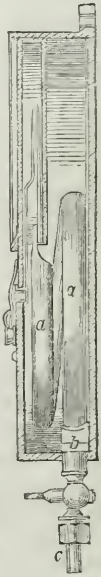


Fig. 2.



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*From the London Artizan, for July, 1851.

Fig. 1 is a front view partly in section, and fig. 2 a side view in section of the gauge. *a a* is the coil of tube fixed at one end to the socket *b*, into which the steam is admitted by the pipe and cock *c*. The other extremity of the tube *d*, is provided with an index, which points to the scale on the dial plate. A second index is provided, as shown in fig. 2, by adjusting which by hand, any fluctuation of the pressure may be conveniently noticed. One of these gauges will be found in the machinery department of the Exhibition, attached to the compressed air receiver on Cunningham and Carter's Atmospheric Railway.

Survey of India.[*]

The trigonometrical survey is at present conducted by seven parties, employed as follows:—Two parties in the Punjaub; one partyin extending the great longitudinal series from Calcutta to Kurrachee, in Scinde; one party on the coast series from Calcutta to Madras, the results of which will be most important to maritime geography; one party employed on the Harelaong series in Behar, if possible to be extended into Nepaul; one party employed in Bengal on the Parasnath series; one party employed in the Bombay presidency. The conclusion of the trigonometrical survey may be expected in six or seven years. The grand total of area triangulated amounts to 477,044 miles, and the total cost to 312,389*l.*

Roofing the Britannia Tubular Bridge.[†]

In consequence of the upper surface of the tubes receiving and being acted on by the wet and atmospheric action, it has been deemed advisable to roof the top of the tubes; a complete ridge has been placed over both the tubes, having a walk down the centre, and the framework has been completely covered over with cloth impervious to the rain. Upwards of 7000 yards of this prepared cloth are required. The large hotel which it has been determined to erect adjacent to the bridge will contain 500 beds, and will be connected with the tubes by a covered walk, and surrounded with appropriate gardens and pleasure grounds. The works are in full operation; large bodies of laborers are employed leveling the ground and forming the foundation.

AMERICAN PATENTS.

List of American Patents which issued from August 12, to September, 9, 1851, (inclusive,) with Exemplifications by Charles M. Keller, *late Chief Examiner of Patents in the U. S. Patent Office.*

20. For an *Improvement in Machines for Cleansing Wool;* Leander W. Boynton, South Coventry, Connecticut, August 12.

Claim.—"What I claim as my invention, is the combination of the tub with the shaft and tube, when these are combined with the vat, (with its trough,) and the whole is constructed, arranged, combined and operated substantially as herein described, for the purpose of cleansing, or for coloring wool and other analogous substances, as herein described."

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[*] From the London Architect, for July, 1851. [†] Ibid.

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21. For *Improvements in Machines for Jointing Staves;* Lewis S. Chichester, Williamsburgh, New York, August 12.

Claim.—"What I claim as my invention, is combining with the adjacent ends of any two plates of the chain, the hinged pieces provided with self-acting toes, for clamping the stave while it is being jointed, and then 'releasing it, substantially in the manner and for the purpose described."

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22. For *Improvements in Spike Machines;* Mark M. Ison, Etowah, Georgia, August 12.

Claim.—"Having thus described my invention, I do not claim the header, or the holding die, irrespective of their arrangement and operation; but what I do claim as new, is the arrangement of the carrier within the hollow table, substantially in the manner described; and also the combination of a carrier, so arranged with a single griping die, arranged with respect to it, in the manner substantially as shown; the die and the carrier assisting each other in holding the spike, while being headed."

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23. For an *Improved Water Guage for Steam Boilers;* Azel S. Lyman, City of New York, August 12.

Claim.—"I claim the combination of the glass tube and a reservoir of fluid below it, heavier than that contained in its upper part, with the legs of a syphon, so that they become a part of that syphon, substantially as described, by which means I am enabled to protect the glass tube from the heat of the steam and impurities of the water; and also to show, at any point above the boiler, the height of the water in the boiler.

"I also claim the combination with the gauge of the sediment depositor, constructed and arranged substantially as described, for the purpose of preventing the impurities of the water from entering the tube leading to the gauge."

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24. For an *Improvement in Machines for Numbering the Pages of Account Books;* John M'Adams, Boston, Massachusetts, August 12.

"The object of my machine is to effect the paging of account books, which has heretofore been done exclusively by hand, in an expeditious and accurate manner, so that the pile of sheets, for a book of any number of quires, may be passed through the machine, and have the number of each successive page printed in any colored ink, in proper position, in the upper corner of each margin of the sheet, and on both sides."

Claim.—"Having thus described my new machine, I shall state my claim as follows: What I claim as my invention, is, 1st, the use of type chains in a machine for printing the pages of account books; and second, a machine for paging account books, having the essential elements herein above described, viz: the imprinting cylinders and rollers, against which they bear, together with the type chains, arranged together, substantially in the manner herein above described."

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25. For an *Improvement in the Manufacture of Pigments;* Hugh Lee Pattinson, Scotts' House, England, August 12; patented in England, February 14, 1849.

Claim.—"I therefore, do not claim this composition of matter; but what I do claim as my invention, is the new manufacture of either a white or colored pigment, by the addition of one half of an equivalent of lime, or other earthly or alkaline base, with one equivalent of chloride of lead, or chloride of lead diffused in water, or however the solution may be obtained; the whole being substantially as herein specified."

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26. For an *Improvement in the Method of Forming Teeth upon Cast Iron Grinders;* Ezra Ripley, Troy, New York, August 12.

Claim.—"I do not claim the casting of ribs or floats, but what I do claim as my invention, is the mode herein subtantially described, of making or forming teeth or grinders upon surfaces of cast iron, by nicking, cracking, or chipping out parts of ribs, or floats, cast thereon, so as to leave the teeth or grinders projecting, as above set forth."

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27. For an *Improvement in Sewing Machines;* Isaac M. Singer, City of New York, August 12.

Claim.—"What I claim as my invention, is giving to the shuttle an additional forward motion, after it has been stopped, to close the loop as described, for the purpose of drawing the stitch tight, when such additional motion is given at and in combination with the feed motion of the cloth, in the reverse direction, and the final upward motion of the needle as described, so that the two threads shall be drawn tight at the same time, as described.

"I also claim controlling the thread, during the downward motion of the needle, by the combination of a friction pad, to prevent the slack above the cloth, with the eye on the needle carrier, for drawing back the thread, for the purposes and in the manner substantially as described.

"I also claim placing the bobbin, from which the needle is supplied, with thread on an adjustable arm attached to the frame, substantially as described, when this is combined with the carrying of the said thread through an eye or guide, attached to, and moving with the needle carrier, as described, whereby any desired length of thread can be given for the formation of the loop without varying the range of motion of the needle, as described."

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28. For an *Improvement in the Construction of Roofs;* Francis Wilbar, Roxbury, Massachusetts, August 12.

Claim.—"What I claim as my invention, is the above described peculiar arrangement of the arched trusses or framing of my improved roof, in combination with the suspending of both inclined sides of the roof, from the ridge timber, so that each inclined side shall be made to counterbalance the other inclined side, and, by so doing, operate to prevent lateral and horizontal thrust upon the side walls; all essentially as specified."

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29. For *Improvements in Sewing Machines;* Allen B. Wilson, Watertown, Connecticut, August 12.

Claim.—"What I claim as my invention, is, 1st, the combination of the rotating hook, to extend the loop on one thread, with a reciprocating bobbin to carry the other thread through the loop so extended, for the purpose of interlacing the two threads together, whether the parts be severally arranged and operated as herein set forth, or in any other way substantially the same.

"2d, The hollow mandrel, constructed substantially as herein set forth, with a groove on its periphery, to give a reciprocating motion to the bobbin, a segmental screw thread to feed the cloth forward as the sewing progresses, and a hook and groove on its extremity, to form loops on the needle thread; in combination with a reciprocating bobbin, the whole arranged and operated substantially as herein set forth."

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30. For an *Improvement in Shoulder Braces Combined with Abdominal Supporters;* John S. Dare, Knightstown, Indiana, August 12.

"The principal object of my invention is so to arrange a brace for the shoulders, or other parts of the human frame, as to afford a firm, yet elastic support, without obstructing the circulation, or interfering with any of the vital functions, or movements of the limbs, and it is in the herein described peculiar arrangements of construction, for the attainment of these objects, that the feature of useful novelty exists."

Claim.—"Having thus described the nature of my improvements, what I claim therein as new, is, 1st, the bars having a common point of junction to a centre bar at the back; passing thence under the arm pits, and thence forward, upward and backward, until their padded extremities bear upon the clavicle; the bar being so formed as to fit snugly, without direct pressure upon the body, except at the points at front and back, as herein explained, giving the desired support to the shoulders, without unnecessary confinement of the person, or obstruction of its various functions, and at the same time affording through the medium of the bar, a firm point of attachment and support for a uterine or abdominal supporter.

"2d, The jointed bar having pads located on each side of the spine, at the junction of the said bar with the braces, the said bar being jointed midways, so as to admit of easy flexion sideways, without compromising the rigidity which is necessary in other directions, and affording by the limited extent of its pressing surfaces, free scope to the circulation, perspiration, muscular action, and other bodily functions."

31. For an *Improvement in Ventilating and Excluding Dust from Rail Road Cars;* Ransom Cook, Saratoga Springs, New York, August 19.

Claim.—"What I claim as my invention is, the combination of the blower bellows or forcer, with the pipes or tubes for conveying the pure air along the train of cars, the pipes or apertures for the admission of air into the cars, the valves or inverted muffles for controlling such admission of air, together with the valves and apertures for regulating the atmospheric pressure within the cars, and its escape from them; all as herein before set forth."

32. For an *Improvement in the Manufacture of Brushes;* Abbot R. Davis, East Cambridge, Massachusetts, August 19.

Claim.—"What I claim as my invention, is the above described improvement in the manufacture of brushes, the same consisting in laying two or more brush blocks or plates together or upon one another, and either boring them before or afterwards, and each with the same number of holes, and so that each hole in each block shall be in range with a hole in each of the other blocks; and passing or inserting bunches of bristles through all the blocks, and fastening the ends of said bristles in the last block through which they are made to enter, and separating the said blocks asunder, and cutting the bristles between the blocks, all substantially as herein before set forth."

33. For an *Improvement in Cooking Stoves;* Hosea H. Huntley, Cincinnati, Ohio, August 19.

"My object in this stove is to attain even baking and cooking in both ovens at the same time, leaving the boiler flue in the enjoyment of the full action of the fire."

Claim.—"Having thus fully, clearly, and exactly described my improvements in double oven cooking stoves, what I claim therein as new, are the closed chambers, and opening in connexion with the space between the hearth plate, fire back, and boiler flue plate and the upper portion of the ovens at their plates; the whole being arranged substantially in the manner and for the purpose described."

34. For an *Improvement in Brick Machines;* Richard Long, Columbus, Ohio, August 19.

Claim.—"What I claim as new in my invention, is, 1st, the mode of controlling the operation of the mould bed carriage, and driving it in either direction by the combination substantially as described, of the toothed wheel on the mud mill shaft, the rack bars and their racks, and arms or ears attached to the carriage, and the slides on the stationary framing.

"2d, The mode of operating the cut-off plate for the purpose of opening and closing the apertures communicating between the mud mill and the moulds, by means of the levers attached to them, and to the framing, in combination with the wheels on the mould bed carriage, substantially as herein shown."

35. For an *Improvement in Cooking Ranges;* Nicholas Mason, Roxbury, Massachusetts, August 19.

"The nature of this invention and improvement consists in combining and arranging a series of boilers, ovens, flues, dampers, and their necessary attachments, in such relation to each other and the fire chamber as to form a compact and convenient cooking range, capable of supplying all the wants pertaining to the culinary department, as well as to form a heater for the rooms of the house in which it is situated, with a slight amount of fuel, considering tho benefits accomplished."

Claim.—"I do not claim to be the inventor of brick ovens, but what I do claim as my invention is the attachment of a brick oven to cooking ranges, to be heated from the same fire with which the cooking is done, as herein described.

"2d, I also claim the hot air chamber at the sides of the perpendicular plates, and extending as high as horizontal plate *i*, and all over curved plate *i i*, and extending all around inclined pipe F, and perpendicular pipe *i* F, and communicating with pipes J, in the manner and for the purpose herein set forth."

36. For an *Improvement in Chemical Processes for Fulling Vegetable and other Textures;* John Mercer, Oakenshaw, England, August 19. Patented in England, October 24, 1850.*

"My invention consists in subjecting vegetable fabrics and fibrous materials, cotton, flax, &c., either in the raw or manufactured state, to the action of caustic soda, or caustic potash, dilute sulphuric acid, or chloride of zinc, of a strength and temperature sufficient to produce the new effects, and to give the new properties to them, which I have hereafter described."

Claim.—"And I claim as of my invention, the process of fulling cotton, linen, and other vegetable fibrous materials, either in the fibre or any stage of its manufacture, or either alone or mixed with silk, woolen, or other animal fibrous material, by means of astringent or styptic materials, as set forth."

37. For an *Improvement in Registers for Omnibus Drivers;* Ira B. Person and Joel L. Brockett, Baltimore, Maryland, August 19.

"The nature of my invention consists in arranging one or more doors, legibly numbered, in a frame, in such a manner that persons paying such specific sums are required to open and pay the same through said doors, and attaching such machinery to such door or doors that it and they, respectively, will, upon being so opened, register in the same manner, hereinafter described, the number of such specific sums so paid during any given time."

Claim.—"What we claim as our invention is, the arrangement of a series of doors, with the attachment to the axes or hinges thereof, of levers or other mechanism, in such a manner, and in such connexion by means of a rod or rods and springs, or other suitable contrivance or device, with a dial or some like mechanism, that each door, upon being opened, will act upon this dial or other mechanism in such manner as to indicate thereon and thereby the number indicated by such door, the several doors indicating different numbers respectively. Also, the arrangement of a strip of metal or other suitable substance, vertically, or in some other position, in connexion with such dial, so that by means of a wedge upon the dial, and pins upon said strip, or *vice versa*, under which, or over which the wedge successively passes, the said strip will rise, or be forced outward from the circumference of the dial a given distance at each revolution of the dial, and indicate by the figures on the surface of such strip near the outward or upward end of the same successively coming in sight above or beyond the circumference of the dial, the number of such revolutions of the dial, using for the construction of the same any metal or metals, or other substance of a suitable or durable description."

38. For an *Improvement in Boot Crimps;* Hartwell Stanley, Wilmington, Vermont, August 19.

Claim.—"What I claim as my invention, is the lever, the knob, the bolt, and the two circular rods, in combination with each other, and with the other parts of the machine, as described, for the purpose of drawing the corners of the front to their proper place at the same time the brake is passing down over it, by turning the screw, and I make no further claim."

39. For an *Improvement in Pulp Screens;* George West, Tyringham, Massachusetts, August 19.

Claim.—"What I claim as new, is the application of the vibrating bottom or bellows to the box, said box being constructed, as described, with the partition, and the screen upon its upper surface, by which arrangement the pulp is forced by atmospheric pressure between the plates of the screen upon the partition, and off the partition into a receiving box, substantially as described."

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* For specification of this patent, see page 202.

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40. For an *Improvement in Ships' Model Measurer;* Abijah S. Hosley, City of New York, August 19.

Claim.—"What I claim as new in my invention is, the employment for the purpose of taking the dimensions of models of ships, and all other vessels, of a pillar or post, having a graduated scale on one side, and an adjustable rest sliding on it, and having also a rule with any number of graduated scales on its face and leg connected with it, both the rule and leg being capable of adjustment in lines at right angles to the face of the pillar or post, the whole being constructed and operated in the manner substantially as set forth."

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41. For an *Improvement in Washing Machines;* David Allan, St. Louis, Missouri, August 26.

"The object of my invention is to provide a machine which will expose the clothes, at every plunge into the cistern or box, to a violent stream of water and suds, which will penetrate every part of them. The usual difficulty of washing machines, so far as my experience goes, is, that the outside ones may be perfectly washed, while the inner ones are scarcely benefitted by the operation."

Claim.—"Having thus fully, clearly, and exactly described the nature, construction, and operation of my improvements in washing machines, what I claim therein as new, is, the chamber or tub with its narrowed neck, and otherwise constructed substantially as described, in combination with the plunger, which latter, with the clothes wrapped around it, passes through the narrowed neck of the chamber, and pressing forcibly on the water confined within the body of the chamber, drives it violently in the direction of the arrows and through the body of the clothes, carrying the dirt with it."

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42. For an *Improvement in Cabbage Cutters;* Hiram Carver, Edinburgh, Virginia, August 26.

"The nature of my improvement consists in furnishing an oblong box, (provided with two parallel knives, secured obliquely in the top thereof, with their cutting edges in right and left positions,) with a horizontal, reciprocating feeding box, provided with a vertical feeder, having handles connected therewith, by which the operator lays hold and actuates the feeding box over the knives, and at the same time rendering it self-feeding."

Claim.—"Having thus described my improvement on the machine for mincing cabbage, what I claim therein as new, is, the two vertical bars, confined to the sides of the feeding box, so as to rise and fall with the movement of the feeder, said vertical bars having handles, by which the operator actuates the feeding box, and by the same exertion of his arms, renders the material self-feeding, simultaneously with the reciprocating motion of the box."

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43. For an *Improvement in Self-acting Cheese Presses;* Bethuel Gillett, and Lyman Allis, Hartford, Connecticut, August 26.

"The nature of our invention consists in the peculiar combination of a falling press frame, with a pair of toggle joint levers, and an eccentric shaped wedge, fixed perpedicular, as shown in plan."

Claim.—"What we claim as our invention is, the combination of the falling frame, with the toggle joint levers, and the fixed eccentric wedge, acting together, and making the upward movement and pressure, substantially as herein set forth and described."

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44. For an *Improvement in Dental Hydraulic Cups;* James Harrison, Jamestown, New York, August 26.

Claim.—"What I claim as my invention, is, the construction of said machine, of two or more plates, with vacancies between the same, and with pipes annexed thereto.

"And also, I claim as my invention, the application of water, or any suitable liquid, to the space or vacancy between the plates, for the purpose of hardening and rendering more firm, the contents of the cup, while on the jaw.

"I claim nothing for the outward form of the said plates, nor for the application of the same to the mouth, merely to take impressions; and I also claim as my invention, the method of using the gate as described."

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45. For an *Improvement in Rotary Harrows;* Jonathan F. Ostrander, Assignor to A. B. & C. E. Hutchins, City of New York, August 26.

"The nature of my invention consists in making a rotary harrow, for breaking or harrowing the ground by means of a spur or toothed wheel, arranged so as to turn or roll forward in the open centre of the harrow frame, when being drawn forward by the horses; and as it rolls forward, by means of a small cog-wheel on the end of the shaft of the spur wheel, gearing into a face cog-wheel on the harrow frame, causes it to rotate simultaneously with its forward motion."

Claim.—"Having now described my invention and the operation of the same, I will proceed to state my claim as follows: what I claim, therefore, is the use of the combination of the spur wheel with the hollow axis, for the purposes and in mode of construction substantially as herein set forth; and their combination with the circular frame, having the face cog wheel and arms attached, for the purpose of producing a rotating harrow, substantially in principle of construction as herein set forth."

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46. For an *Improvement in Padlocks;* George McGregor, Robert Lee, and Thomas G. Clinton, Cincinnati, Ohio, August 26.

Claim.—"Having thus fully, clearly, and exactly described the nature, construction, and operation of our improved mail-bag spring and safety padlock, what we claim therein as new, is, the combination of the bolt *p*, and cavity *y*, on the rotating end of the hasp, with the tumblers *a* and *g*, having the characteristics described, or their equivalents; the tumblers, hasp, and bolt, constituting a system of fastenings within and without the casing of the lock; the whole being arranged and operated, substantially in the manner and for the purpose described."

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47. For an *Improved Adjustable Tool Haft;* Peter H. Niles, Boston, Massachusetts, August 26.

"The nature of my invention consists in the mode of closing the jaws of the gripe."

Claim.—"I do not claim the gripe as any novelty, but what I do claim as my invention is, the mechanism by which its jaws are closed, the same consisting of the eccentric groove, the pin, and the revolving tube, as described in the above specification, and shown in the accompanying drawings."

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48. For an *Improvement in Insulators for Lightning Rods;* George W. Otis, Lynn, Massachusetts, August 26.

Claim.—"What I claim as my invention, is the insulated support and point for lightning rods, consisting of the insulated point and opening in its shank, the insulating cylinder of glass, with its lip or flanch, and the wooden collar for securing the whole to the building, all as described."

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49. For *Improvements in Breech-loading Fire-Arms;* Horace Smith, Norwich, Connecticut, Assignor to Cortlandt Palmer, City of New York, August 26.

Claim.—"What I claim as my invention is, operating the breech pin directly by the finger lever, as herein described, in combination with the breech pin and abutting lever, formed and operating substantially as herein described, and for the purpose specified.

"I also claim elevating the charge lifter by the direct contact of the breech pin carrier, with an arm of the lifter lever, and depressing it by the direct contact of the finger lever with the other arm of the said lifter lever, as described."

50. For an *Improvement in Padlocks;* David Tilton, Stoneham, Massachusetts, Assignor to David Tilton and Samuel Sweetser, Boston, Massachusetts, August 26.

Claim.—"What I claim as my invention, is the combination of the turning hasp, or contrivance, the tumbler, and the slide, and its projection, or any mechanical equivalents, the whole being made to operate together, substantially as described."

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51. For an *Improvement in Lime Kilns;* Samuel Brown, Berwick, Pennsylvania, August 26.

Claim.—"Having thus fully described my invention, what I claim therein as new, is, 1st, so forming the fire space in lime kilns, which are fixed at both ends as to rise gradually from the centre of the kiln, to points above the eyes in each end thereof, substantially as herein described, for the purpose of so distributing the draft and heat as to secure the even burning of the stone.

"2d, I claim dividing the fire space, by a partition wall in the centre, into two chambers, for the purpose of shifting and regulating the heat required in either end of the kiln, substantially as herein described, for the more evenly burning of the stone.

"3d, I claim, in combination with the fire chambers and partition wall, the ash pits a each end of the kiln, connected by a narrow flue, so that when the eye at either end may be closed for shifting the heat, sufficient draft will be kept up from the opposite end of the flue, to allow the fire to burn moderately, without being entirely extinguished, as herein fully set forth."

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52. For an *Improvement in Horizontal Square Piano Fortes;* George Bacon and Richard Raven, City of New York, August 26.

Claim.—"What we claim as our invention or improvement, is connecting and combining, in the horizontal square piano forte, in one piece of cast iron, or other metal or metals, the bridge, the brackets, the upper bearing by the flanches, the reverse bearing on the buttons, the application of the long bridge of the horizontal square piano forte, of the method of firmly screwing the whole to the rest-plank by means of the screws, and the application of the diagonal position of the face of the flanch so as to make both strings of each note of equal length, to metal bridges on horizontal square piano fortes, as seen at H, in the manner and for the purpose intended, described in this specification, and seen in the model and drawings by which it is accompanied."

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53. For an *Improvement in Means of Obviating Difficulties arising from Defective Insulation of Telegraphs;* Charles S. Bulkley, Macon, Georgia, August 26.

Claim.—"Having thus fully described my improvements in the working of telegraphs, what I claim as new therein is, reversing the connexion of the main wire with the poles of the battery, so that the battery acts in opposition to the battery at the other end of the line, in the intervals between the contacts made by the key in writing, (in place of merely breaking the circuit.) by means of the apparatus and arrangement of wires, batteries, &c., substantially as above described, for the purpose of counteracting the effects of imperfect insulation, as set forth."

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54. For an *Improved Nut and Washer Machine;* Henry Carter and James Rees, Pittsburg, Pennsylvania, August 26.

Claim.—"We claim the two punches, moved at the same time with different velocities, and in the same direction, in combination with a die box, within which the nut is formed, substantially as herein set forth."

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55. For an *Improvement in Machinery for Cutting Glass;* John P. Colné, City of New York, August 26.

"My invention relates to an improvement in glass cutting machinery, and is also applicable to the cutting and shaping of crystals, stones, gems, and all articles which are shaped by grinding with gritty substances."

Claim.—"What I claim as my invention is, 1st, the combination and arrangement of the several parts for giving the reciprocating and circular movements herein described, that is to say, the combination of the bed plate and revolving plate with the carriage, consisting of the pieces K L M.

2d, "The method of guiding the movements, and adjusting the several parts of the machine, for the purpose of directing the course of the object to be shaped or figured, in passing the edge of the cutting wheel, by means of movable lettered or named stops and gauges, prepared for particular patterns, and applied to the machine as required, the whole being constructed and operating substantially as herein set forth."

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56. For an *Improvement in Self-Acting Blowpipe Lamps;* David W. C. M'Closkey, City of New York, August 26.

"The nature of my invention consists in the application to the ordinary self-acting blow-pipe lamp of a safety valve, and escape pipe, in such a manner as to regulate the pressure of the gas in the gas chamber, and thereby prevent any accident with the lamp, and also in combining with the blow-pipe a cut-off, or stop cock, for the purpose of diverting the current of gas through the escape-pipe, and of regulating the volume of gas passing through the blow-pipe."

Claim.—"Having now described the mode of construction and operation of my improved lamp, I will proceed to state what I claim: I claim, therefore, the use of the safety valve and escape pipe, and stop cock, in combination with the blow-pipe of a self-acting blow-pipe lamp, substantially as herein set forth."

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57. For *Improvements in Machinery for Forming Joints of Elliptical Springs;* William T. Richards, New Haven, Connecticut, August 26.

Claim.—"I claim the combination of the hollow die, with the lower die, and half circular shears, actuated in the manner substantially as herein described, and for the purposes herein set forth."

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58. For an *Improvement in Cut Nail Machines;* John P. Sherwood, Fort Edward, New York, August 26.

Claim.—"What I claim as my invention, is, 1st, in combination with knives, or the equivalent thereof, for cutting blanks sidewise from nail plate, a traveling griping and heading tongs, or jaws, opening and closing in a direction perpendicular to the face of the nail plate, and constructed and actuated substantially as herein set forth, to gripe the blank on its flat sides, without the necessity of turning it upon edge, as is customary with nail machines heretofore constructed, to draw it from beneath the knives, and to hold it while being headed.

"2d, I claim the direct acting knife-stock, with knives secured to its opposite sides in such positions, with respect to the stationary knives, or to each other, that the knife upon one side cuts after the knife upon the opposite side, in combination with a double graded cam, or other equivalent actuating mechanism, which shall cause the cutter bar to descend with two impulses, at each of which one knife acts to cut a nail blank.

"3d, I claim the relative arrangement of the traveling griping jaws and heading tool, the latter being actuated within the former, and traveling with it.

"4th, In combination with two sets of knives, acting alternately, to sever nail plates, I claim a reciprocating griping and heading carriage, which, traveling to and fro between the two sets of knives, gripes, heads, and delivers a nail at each single stroke, in alternate succession, at its opposite extremities, whereby much time and labor are saved; and the machinery to cut a given number of nails, is condensed into a less space."

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59. For an *Improvement in Spike Machinery;* James H. Swett, Concord, New Hampshire, August 26.

"The nature of my invention consists in the raising up of the end of the spike in the die, after being headed, so that the next following blank will be drawn underneath it, and tilt it out of the die, as said blank is drawn forward by the nippers, and which prevents the possibility of a spike and blank being in the die at the same time, and the consequent breaking up of the machine."

Claim.—"Having thus fully described the nature of my invention, what I claim therein as new, is, the method of delivering the spikes from the die, by means of the tilting rod, and the movable nippers, so as to allow the nippers to draw in the succeeding blank underneath the spike, and tip or tilt it out of the die, which prevents the possibility of a spike and blank being in the die at the same time, and the consequent breaking up of the machine."

Design for August, 1851.

1. For a *Design for Ladies' Combs;* Aaron Cook, Newtown, Connecticut, August 19.

Claim.—"What I claim as new and original, is the design A, placed on the top or upper part of the comb, formed or composed of the series of oblique rings, as herein represented and described."

SEPTEMBER.

1. For an *Improvement in Rules for Calculating Interest;* Samuel S. Young, Assignor to John R. Stephen, Eaton, Ohio, September 2.

"The nature of my invention consists in providing a simple mechanical method of performing the most difficult calculations in interest, and the laying of taxes."

Claim.—"What I claim as my invention is, the arrangement of parallel slides, substantially in the manner and for the purposes herein set forth; one slider being for units, another for tens, another for hundreds, &c., and each slider being so graduated and numbered as to show through the vertical opening, the same denoting the interest or tax on the numeral figure that appears on the same slider, at the side of the bar, as herein described."

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2. For an *Improved Saw Filing Machine;* Thomas M. Chapman, Old Town, Maine, September 2.

Claim.—"What I claim as new, is the swinging frame, constructed as described, and for the purpose specified, viz: by having the arms firmly attached to a rod; the ends of the said rod working freely in holes or bearings in the ends of the arms, which are attached to the horizontal rod, by which arrangement the swinging frame has an up and down motion, owing to the rod turning in its bearings; also a horizontal reciprocating motion, the same as the rod, and a forward and backward motion, by which, with the aid of the file, turning on its axis in the frame, the file may be so adjusted as to operate both upon the front and back of the saw teeth, substantially as set forth."

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3. For an *Improvement in the Method of Securing Wheels to Axles;* Junius Foster, Green Point, New York, and David Marsh, Bridgeport, Connecticut, Assignors to Junius Foster, Green Point, New York, September 2.

Claim.—"We do not claim the securing of a hub to an axle by means of a groove around the inner end of the hub, or a bead on the axle; but what we do claim as new and of our own invention, is the application of the cylinder 5, and flanch *f*, on the axle, in combination with the cylinder *e*, flanch 3, couplings 7, keys 12, and coupling box *g*, to retain the plate *d*, of the hub, and allow its rotation between the flanches 3 and *f*, without any tendency to uncouple the hub from the axle, substantially as described and shown."

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4. For an *Improvement in Double Oven Stoves;* Conrad Harris and Paul W. Joiner, Cincinnati, Ohio, September 2.

Claim.—"Therefore, having thus fully, clearly, and exactly described our joint invention and improvement in double oven stoves, wherein the front oven extends under the fire-place, or fire-place and hearth, as may be desired; what we claim therein as new, is the damper *a*, constructed and arranged as described, so that one or both ovens may be used at pleasure.

"We also claim the flue between the ovens, substantially as constructed and arranged to communicate directly with the exit flue.

"We also claim projecting the cold air chamber into the flue under the fire-place, and there discharging the received air so as to protect the oven from being over heated at that point."

5. For an *Improvement in Moulding and Casting Stereotype Plates;* Charles Hobbs, City of New York, September 2.

"The nature of my invention consists in moulding and casting any given number of stereotype plates at one operation; besides making them more rapidly than can be made by any other known method, it makes them more perfect."

Claim.—"What I claim as my invention is, 1st, the moulding, in plaster, of one or more forms of type, wood cuts, medals, &c., at one operation, in air-tight vessels, by means of exhaustion.

"2d, I claim the making of the plaster moulds with two faces.

"3d, I also claim the casting from one or more moulds, in a box sufficiently tight to hold fluid metal, and bringing the face perfect by means of the weight of fluid metal confined above them in column, or otherwise.

"4th, I also claim the grooved wedges for retaining the moulds in their places while casting from them.

"5th, I also claim the non-admission of fluid metal to the moulds until the orifice through which it enters is sunk beneath the surface of the fluid metal, thus preventing the dirt and dross from entering with it."

6. For an *Improvement in Drying and Oxidizing Colored Goods;* James C. Kempton, Manayunk, Pennsylvania, September 2.

Claim.—"What I claim as my invention, is the application of atmospheric pressure, or the mechanical pressure of air, in the coloring of cotton, wool, or other substances; for removing the excess of liquor absorbed from the vat, and for oxidizing or fixing the color by its forced passage through the mass, and by the use of apparatuses, substantially as herein described."

7. For an *Improvement in Mercury Baths for Photographic Purposes;* John Moulson, Philadelphia, Pennsylvania, September 2.

"The nature of my invention consists in the agitation of the mercury or other substances used immediately previous to the exposure of the photograph impression to its influence, and upon a cooler surface than that of the mercury cup proper, which I generally expose to constant heat, throwing off the said heated surface of the cup, the mercury or other substance, when not intended for use, thereby to cool it and to agitate it, and to prevent its evaporation, or vaporization when not in use; all of which I am enabled to do by means of my 'moving lever cup bath for photographic purposes,' with or without my double plate holding slide."

Claim.—"What I claim as my invention, is my moving and movable lever cup, or its equivalent, and bath, for photographic and daguerreotype purposes.

"I claim the agitation of the mercury upon a cooler surface immediately previous to its use in the heated cup (or part of it), for the development of photographic impressions, by means of my movable lever cup, or its equivalent.

"I claim the lever cup, or elongated cup, movable perpendicularly on an axis or centre of motion, which centre of motion need not be confined to a particular part of the cup, but it may be varied and placed in any manner giving and admitting the movement of the cup, but must be so arranged as that the mercury, or other substance, may flow from the heated surface of the cup to the cooler surface of the tube or elongated cup, and *vice versa*, by elevating or depressing the exterior end of said cup.

"I claim the balancing of said lever cup, or its equivalent, on the centre of motion, wherever placed, so that it will remain stationary, when the weight of the mercury, or other substance, is let on to either end of it; that end containing the mercury or other substance used being held down."

8. For an *Improvement in the Method of Raising Sunken Vessels;* William Irwin, Philadelphia, Pennsylvania, September 2.

Claim.—"I claim the combination of the inflatable air receiver, purchase, roller, and wedge, or their equivalents, as herein described, for the purpose of raising and supporting vessels."

9. For an *Improvement in the Construction of Bridges;* Edwin Stanley, Bennington, New York, September 2.

"The nature of my invention consists in making the arch which is intended to sustain the thrusting force of the load, of wood and iron, so combined and constructed as to afford a firm and durable iron bearing for the upper end of the braces and uprights; while I, at the same time, make the principal part of the arch of wood, combining it with the iron portion of the arch in such a manner, that it can, when decayed, be removed in portions and be replaced with new, without destroying any other part of the structure, by which means I am enabled to secure in the same arch the lightness, cheapness, and security of wood, and the durability of iron."

Claim.—"What I claim as my invention, is the method above described and shown of making the thrust arches of bridges, that is to say, I claim the arch constructed partly of wood, and partly of iron, when arranged in the manner herein specifically set forth; the iron parts of the arch being constructed in such a manner as to afford a firm bearing for the braces and uprights, with a projecting flanch of sufficient width to shelter the wooden part of the arch as herein set forth, and the wood being bolted upon the sides, under cover of the flanches of the iron, in such a manner that the wood upon one side can be removed and be replaced without disturbing that on the other, the whole being constructed and put together, substantially in the manner and for the purposes herein set forth."

10. For an *Improvement in the Construction of Violins, &c.;* William B. Tilton, Carrollton, Alabama, September 2; ante-dated April 8, 1851.

Claim.—"Having thus described the construction and effect of my improvement of the violin, &c., what I claim as my invention, is the introduction into the body of the instrument of the brace bar, or supporter, constructed of any suitable material, and of any requisite form, between the upper and lower extremities thereof, inserted either into blocks of wood, A and B; or, instead of A, into an elongation of the neck to answer the same purpose, by which means I am enabled to give strength to the instrument, to resist the strain of the strings, and disconnect the sound board, and the table or back from the blocks A and B, said brace or supporter sustaining the tension of the strings, preserving in tune, and also materially improving the tone, in quality, volume, and melody, of instruments to which this improvement is applicable.

"I also claim the manner of increasing the vibration of the sound board, and the table or back, by the cutting away or removing the before described portions of blocks A and B, in the manner and for the purpose set forth in the foregoing specification and accompanying drawings."

11. For *Improvements in Cider Mills;* Nathan Chapin, Syracuse, New York, September 2.

"The nature of my invention consists in a new method of grinding apples, together with the method of removing the platform of the press for the purpose of disposing of the pumice, after it has been pressed."

Claim.—"What I claim as my invention, is the cast iron grinders, arranged and constructed as described, viz: so as to force the apples, while being crushed, from the centre towards the periphery of the plates; and at the same time to force a portion of the pumice through the holes in the lower plate of the grinders.

"I also claim the method of removing the cheese of pumice from the press crib, viz: by detaching the platform from the press crib, and using the same for a sled to draw the cheese from the mill, substantially as described."

12. For an *Improvement in Circuit Changers for Electro-Magnetic Telegraphs;* Charles S. Bulkley, Macon, Georgia, September 2.

Claim.—"Having thus fully described my improvements, what I claim as new therein, is the circuit changer, substantially as above described, in combination with the arrangement of wires, magnets, &c., as set forth, for the purpose of enabling the operator at either one of two distant stations to arrange the connexions at the intermediate stations, so that he can write through to the other end station at pleasure."

13. For an *Improvement in Machines for Making Sod Fence;* H. L. F. Gavett, Jackson, Michigan, September 9.

"The nature of my invention consists in so arranging a series of cutters and mould boards, as that two wedge shaped slices of sod will be cut and gradually turned up upon their broader edges, when they are caught between rollers, so adjusted as to press them close together; the transverse axis of said rollers being inclined, so as to make a lifting and pressing motion in an upward direction, and making at one and the same operation a compact sod fence, with ditches on both sides thereof."

Claim.—"Having thus fully described my invention, what I claim therein as new, is, the combination of the cutters and mould boards for cutting and turning the sod on edge, with the inclined adjustable spring rollers, for raising, packing, and forming the sods into a fence, as herein described and represented."

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14. For an *Improved Hook Heading Motion for Spike Machines;* Moore Hardaway, Troy, New York, September 9.

"My improvement consists in the employment of a header, in such a manner, that when the rod of iron shall have been fed into the dies, the header will be made to descend and bend the end of the rod downward, and after a limited pause in the movement of the header, be made to advance horizontally and press said rod against the dies, and thus form the hook head."

Claim.—"Having thus described my improvements on the machine for making hook headed spikes, what I claim as new and of my own invention, is, the employment of a header, made to have a descending, and afterwards a horizontal frontward movement, for the purpose of first bending the end of the piece of iron downward, and then forcing it horizontally against the end of the die, and thus form a hook head as described and represented."

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15. For an *Improvement in making Sails;* Eli F. Southward, Wellfleet, Massachusetts, September 9.

"The nature of my invention consists in so arranging the cloths of the square sails, that the whole cloths are at the leeches, and run parallel with the leeches and the goring cloths, all meet in the bunt of the sail, arranging the straight cloths as in plate 1st, figures 2d and 3d, numbered 1, 2, 3, 4, 5, 6, &c., and the goring cloths as in same plate, and figure, numbered 10, 11, and 12."

Claim.—"What I claim as my invention is, the bringing straight cloths upon the leeches, and making all the head cloths parallel therewith, and uniting the goring cloths in the bunt of the sail, as described above."

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16. For a *Gold Amalgamator;* William Ball, Chicopee, Massachusetts, September 9.

Claim.—"What I claim, therefore, as my invention is as follows: I claim the combination of the partition (dipping below the surface of the water), with the lower distributor, provided at the centre with a discharge aperture for the water and light particles, and at the periphery, with apertures for the discharge of the water and heavier particles, for the purpose of preventing the escape of gold over the central or waste pipe.

"I also claim the arrangement of the sliding tube ferrule, or waste gate, directly upon the hollow axle of the lower distributor, the same being for the purpose of regulating the head of water within the said distributor.

"I am aware that it is not unusual in gold washers, to use a succession of baths; therefore, I do not claim such arrangement in general; but

"I also claim arranging the secondary mercury bath, concentric with and below the primary one, in such a manner, that the currents of water, et cetera, return towards the centre of the apparatus; thereby saving room and causing the said currents to pass more slowly."

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17. For *Improvements in Equalizers of Power Regulators;* Alfred Gregory, Brooklyn, New York, September 9.

"The nature of my invention consists in causing the steam, gas, or other propelling medium, contained in the boiler, or reservoir, which supplies the engine, to operate, (in lieu of air under ordinary atmospheric pressure, as heretofore,) upon the piston of the "Equalizer," the said piston being connected with the engine, or other mover, and operating therewith in a similar manner as with former "Equalizers," or in any other appropriate way."

Claim.—"I will proceed, distinctly, to state that I do *not* claim the mere employment, as an "Equalizer," or regulator of a piston, operated by, and acting against pressure, alternately, each stroke; the said piston having two strokes for one of the engine or other mover it works in connexion with, as such has already been done; nor do I claim, separately exposing the equalizer piston to the vacuum of the condenser; but what I do claim as my invention, is the use of steam, or other gas, to operate upon the piston of the power regulator, or "Equalizer," the said steam, or gas, being derived from the same reservoir that supplies the engine."

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18. For an *Improvement in Sword Canes;* Samuel A. Hudson, Worcester, Massachusetts, September 9.

Claim.—"What I claim as my invention, is a sword cane, constructed substantially as herein set forth, viz: consisting of the rod, with blade attached, passing through the entire shaft, and giving point beyond it, whether the said rod be or be not connected with a spiral spring, to draw the blade back into the handle.

"I do not claim the application of the spiral spring, as an adjusting power, nor do I claim the screw applied as a stop, neither of which being substantially new."

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19. For an *Improvement in Washing Machines;* Erastus Lawrence, Dublin, Indiana, September 9.

"My invention consists in a system of mechanical devices, which are operated conveniently by hand; and by whose action, clothes and other articles are thoroughly rubbed and turned to be rubbed on different surfaces, or in different positions, in a manner closely resembling the manipulations of the washerwoman, but without being touched by the hand of the operator."

Claim.—"What I claim as my invention is, the combination, substantially as described, of the levers, link-bar, and rubbing-board, for the purposes herein specified."

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20. For an *Improvement in Axles of Wheeled Cultivating Ploughs;* G. W. C. Gillespie, Burlington, Iowa, September 9.

"The nature of my invention consists in hanging one or both of the axles of the wheels of the carriages of cultivators, gangs of ploughs, seed drills, etc., to the frame of the carriage, when the ploughs or cultivators are placed diagonally one behind the other, so as to vibrate them by levers, or other means, or suffer them to vibrate of themselves, so as to assume a position at right angles to the track of the wheel, when moving in a straight line, and when turning in a line nearly parallel to the radius of the circle formed by the track of the wheel; so that such carriages and their appurtenances may be turned about with facility, without the risk of breaking the same."

Claim.—"What I claim as my invention is, hanging one or both of the axles of the wheels, to the carriages of cultivator gangs of ploughs, seed drills, etc., to the frame of the carriage, so as to vibrate the axle, or axles, or suffer them to vibrate, and keep them at right angles to the motion of the ploughs, when moving in a direct line; and when turning the ploughs, to keep the axle or axles in the direction of the radius of the circle, or nearly parallel with the radius of the circle formed by the track of the wheel turning upon said axle; when the ploughs constituting the gang, are placed diagonally, one behind the other, in succession, and the wheels to the carriage of the same, are also placed diagonally, one behind the other."

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21. For an *Improvement in Type Casting Machines;* John J. Sturgis, Assignor to H. H. Green, City of New York, September 9.

"The nature of my invention consists in the arranging of a slide rest, for the support of the mould blocks in a frame, so as to have an oblique side inclination, for facilitating the dropping of the type from the mould block, when opened, and a forward horizontal slide motion, for presenting the mould block to the nipple of the fused metal bath; also, the combining therewith, the mould blocks, and the arrangement of certain levers, for the opening and closing the said mould blocks, and operating or relieving the matrix, all for the purpose of producing a more perfect and expeditious mode of casting printers' type."

Claim.—"Having now described my invention and the operation of the same, I will proceed to set forth what I claim. What I claim, is, 1st, the employment of the lever, having an adjusting slot-adjuster, matrix spring holder, and their combination with the horizontal slide, slide ways, and matrix spring, substantially in form and manner, and for the purposes herein set forth.

"I claim also the employment of the adjusting, supporting piece, and the combination therewith of the horizontal slide and levers, substantially, in form and manner, and for the purposes herein described.

"And I also claim the combination and arrangement of the horizontal slide, slide ways, and levers operated thereby, for the purpose of obtaining a horizontal and oblique action of the machine."

22. For an *Improvement in Piano Forte Action;* Randolph Kreter, City of New York, September 9.

Claim.—"What I claim as my invention, is the repeating check, or tongue, connected with a lever, hinged to the hammer rail, and resting on the key; the under side of the hammer but being provided with an arm, which rests against the upper end of the face of the repeating check, substantially as and for the purpose specified."

23. For an *Improvement in Dental Forceps;* J. C. Burch, Evansville, Indiana, September 9.

Claim.—"What I claim as my invention, is, the compound lever forceps, above described; or the compound lever, and the movable fulcrum, applied to forceps, by means of which the roots of decayed or broken teeth may be readily and easily reached, and extracted."

24. For an *Improvement in Piano Forte Action;* James A. Gray, Albany, New York, September 9.

"The nature of my invention consists in having an independant movable or oscillating shoulder attached to the hammer but for the hopper to act upon, in throwing the hammer against the strings of the piano forte; and also the extension of this shoulder downwards, so as to connect with a spring."

Claim.—"What I claim as my invention, is, in having the shoulder under which the hopper plays, attached to the hammer but by a centre pin, forming an independent oscillating shoulder to the hammer but, (said shoulder being usually detached from the hammer but, or composing a part of it.)

"I also claim the extensien of tho back part of the shoulder down, so as to connect with a spring."

25. For an *Improvement in Piano Forte Action;* Robert M. Kerrison, Philadelphia, Pennsylvania, September 9.

Claim.—"What I claim as my invention, is the jack, consisting of a crooked lever, and a straight or nearly straight lifter or pusher, acting conjointly on the general principle above illustrated.

"And I also claim the peculiar application of the spring to govern the alternate bending and straightening of the jack, by acting one prong or tooth between two other prongs or teeth, with due allowance of play, or shake, according to the desired degree of drop of the hammers from the string, known as the scape."

26. For an *Improvement in Fastening Hooks and Eyes to Paper Cards;* Chester J. Carrington, Waterbury, Connecticut, September 9.

Claim.—"I claim nothing for the machinery for which the work is done; nor for tho mortise-like holes, which belong to Atwood's patent; but what I do claim as my invention, is the confining of the eye by means of the longitudinal cut, or slit, or cuts or slits, (whether one or more is used,) in the card parallel with the rows of holes, admitting through it or them, a portion of the eye, as herein described and applied, or in any manner, substantially the same."

27. For *Improvenents in Gauges used in Turning;* Chauncey R. Hurlbut, Waukau, Wisconsin, September 9.

Claim.—"What I claim as my invention, is the gauge, with its graduated slide, capable of being set to any given diameter, the whole being suspended upon a horizontal wire, and operating as herein set forth."

28. For an *Improvement in the Manufacture of Paints;* Guillaume Ferdinand de Douhet, Paris, France, September 9. Patented in England, June 1, 1850; in France, October 5, 1850.

"The deoxydation, or loss of oxygen, which is undergone by certain bodies, imparts to them new properties, useful to the arts and industry.

"It is this deoxydation and the applications resulting therefrom that form the object of this invention."

Claim.—"What I claim as my invention, is the manufacture, by the processes substantially as herein described, of new colors fit for painting, whether with oil, varnish, spirits of turpentine, or water, by means of the deoxydation of the soluble metallic sulphates of zinc, copper, iron, and other metals, and by the precipitation of their bases, either by alkaline hydrosulphurets, whose sulphates are soluble, such as those of soda, potash, and ammoniac, to obtain colors with a single metallic base; or to obtain colors with a double base, partly metal, and partly alkaline sulphate, by using the alkaline hydrosulphurets, whose sulphates are insoluble, such as those of baryta, of strontian, and of lime, and even by the hydrated sulphuret, and polysulphurets of lime, prepared directly, substantially as herein set forth."

MECHANICS, PHYSICS, AND CHEMISTRY.

For the Journal of the Franklin Institute.

Notes on the U. S. Steamer "Bibb." *By* B. F. Isherwood, *Chief Engineer U. S. Navy.*

The *Bibb* was one of four steamers built in 1843–44, for the Treasury department, with Hunter's submerged wheels. She was the last one constructed on that plan, and cost $145,604·13. The others were the

M'Lane, . .	83,338·69
Dallas, . . .	82,952·23
Spencer, . .	105,013·10
Total,	$416,908·15

These four miserable abortions were of the same dimensions, viz: 148 feet in length, 23 feet beam, 14 feet hold, having a mean draft of water of 10 feet loaded, and 8 feet light; the mean being $7\frac{1}{2}$ feet forward, and $9\frac{3}{4}$ feet aft. They cost nearly enough to build a first class steam frigate. The steam frigate *Kamschatka*, constructed at New York for the Russian government, and displacing 2468 tons, cost only $400,000.

The *Bibb's* burthen was, by measurement, 409 tons. She was built at Pittsburg, Pa., and never made but a trial trip with Hunter's wheels. On leaving Pittsburg for the first time, after a vain attempt to stem the current of the Ohio river, so as to display her before the town, she was put about and steamed, or rather drifted down the river for a few hours, when she was found to be fast sinking, the steps of the wheels having become cut out; the water soon drove the engineers from the engine-room, and as a last resort, the vessel was run ashore. The leak was stopped after great detention and expense, and the vessel finally towed down to Cincinnati by a river steamboat, where the Hunter wheels were ordered to be taken out by the disgusted department, and common side wheels, with a single side lever engine, substituted. These necessary alterations were effected at a cost of about $30,000; the vessel has since undergone no further alteration.

The *Bibb*, while used as a revenue cutter, carried an armament of one long iron eighteen pounder, and four iron thirty-two pounders; but, in common with all the steamers built for the use of the Treasury department, she proved wholly unfitted for that service, and like them, has been disposed of for other purposes, the *Bibb* falling to the Coast Survey.

These steam revenue cutters were all very unfortunate in their machinery, which was continually breaking down, causing them to be the greater part of the time laid up for repairs, which were soon found too costly for the value of the vessels' services. They were originally intended to be propelled by steam as an auxiliary power, and to depend on their sails for the most of their cruising; but their sailing was even worse than their steaming qualities; for in order to diminish the resistance of the hulls, so as to obtain a respectable speed from the Hunter wheel, they were made so sharp and crank that they could not carry sail; while in order to obtain a high rate of speed under sail alone, they were so heavily sparred as to be quite unsafe in heavy weather, and fully justified the opinion of Captain Fraser, that the spars would "require great reduction before it is safe to send them (the vessels) to sea."

For revenue purposes, a vessel should not exceed 200 tons burthen, while these were double that measurement, and were yet deficient by about 8 feet of beam to have stability under canvass; in fact, none of these vessels would stand up under canvass, nor could they be *stayed* under ordinary circumstances; while in bad weather it was difficult to *wear* them, or *lay them to.* A fresh wind abeam buried the lea side paddle wheel nearly up to the shaft, and they were altogether unmanageable in a gale at sea.

Notwithstanding that the steam power was intended to be auxiliary to the sails, the machinery occupied so large a space that it was found necessary, in the *Bibb*, to remove the captain's quarters from below to the spar deck.

These vessels was an attempt to do a great deal with a very little. They were to outsail the fastest sailing vessels with sails alone; they were to equal the fastest sea steamers under steam alone; they were to consume almost nothing in coal, and to carry a sufficient amount of that desirable article for an incredible length of steaming. Utterly deaf to the admonitions of scientific induction and professional experience, the government, listening only to the asseverations of the inventor, went on building failure after failure on this plan; and with singular perseverance, would commence a new vessel on the very same design of one which had just proved an irredeemable failure.

The *Bibb*, like the others of its class, was an iron vessel, and like them, subject to very rapid fouling of the bottom, by the attachment of marine plants and shells; so rapid was the growth of these parasites, that three or four months cruising in the southern waters covered the immersed portion of the hulls with grass of several feet in length, and thick clusters of oysters, barnacles, &c., to the great reduction of the vessel's speed.

The *Bibb* was about 460 tons displacement at mean draft with an immersed amidship section of about 167 square feet. The hull was 143 feet between perpendiculars.

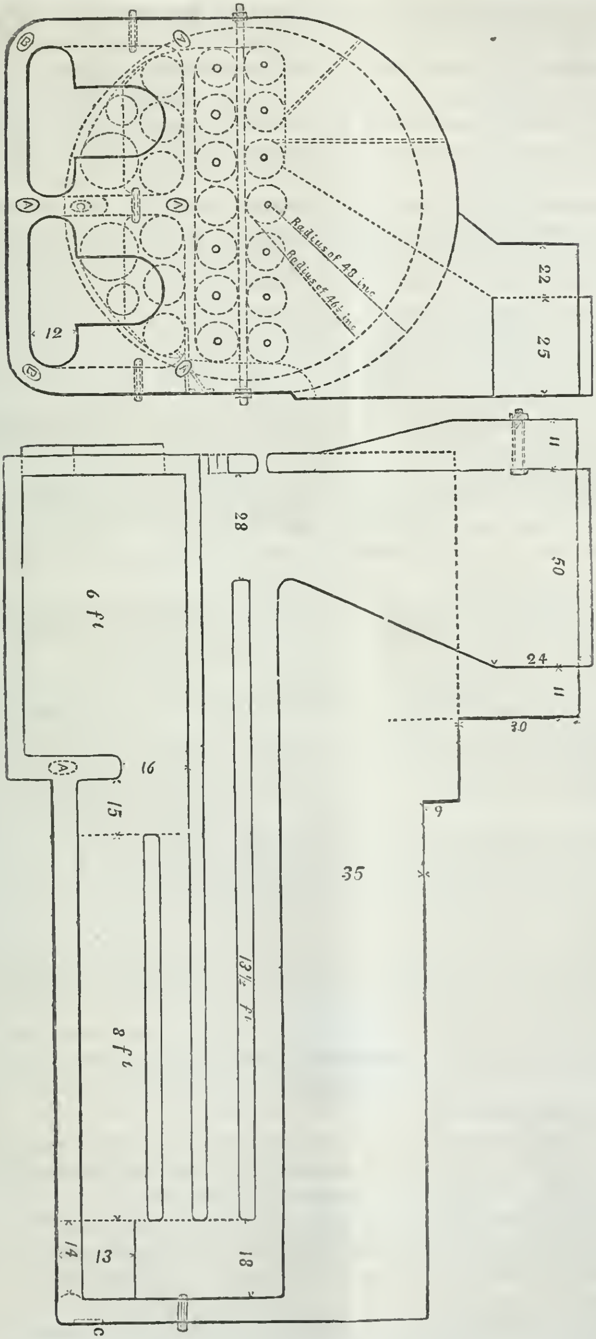
Engine.—One side lever; diameter of cylinder 50½ inches; stroke of piston 4 feet 7 inches; capacity of space displacement of piston 63·76 cubic feet.

Paddle Wheel.—Of the common radial kind, 16 feet from outside to outside of paddles; 16 paddles in each wheel; length of paddle 7½ feet; breadth of paddle 22 inches; immersion of lower edge of paddle 42 inches at mean draft of vessel.

Boilers.—The boilers of the *Bibb* were of iron, two in number, of the return ascending flue kind, furnished with a steam chimney, or drum, around the smoke chimney. The furnaces were 6 feet long, and 3 feet 4 inches wide, containing in the aggregate 80 square feet of grate surface. The lower flues were 15, 9, and 10 inches diameter, the upper ones 9½ inches diameter; and the length of circuit traversed by the heated gases, from their entrance into the flues to their discharge into the smoke chimney, was 21½ feet. Total heating surface in both boilers 1732 square feet. Calorimeter, or cross area of lower flues (in both boilers) 13·21 square feet; of upper flues 13·78 square feet. Area of smoke chimney 13·63 square feet. From these figures it appears that the calorimeter was sensibly the same throughout. The proportions of the boiler would therefore be as follows, viz:—

Grate to heating surface, 1·00 to 21·65; calorimeter, or least cross area of flues to grate surface 1·00 to 6·06; square feet of heating surface per cubic foot of space displacement of steam piston 27·17 to 1·00.

With the above proportions, the boilers generate steam enough to fill the cylinder 38 times per minute with steam of 15 pounds boiler pressure above the atmosphere, cutting off at half stroke; using anthracite coal, with moderate blowing, at the rate of 11 tons per 24 hours. The capacity of the space displacement of the steam piston being 63·76 cubic feet; one-half of it would be 31·88, to which must be added 3·16 cubic feet in the clearance and steam passage between valves and cylinder at one end of the cylinder; making a total of 35·04 cubic feet of steam used per stroke of piston. With 38 strokes per minute this would be 79891·20 cubic feet of steam per hour, and taking the relative bulks of steam of the total pressure of 28 pounds per square inch (which allows the initial pressure in the cylinder to be 1·7 pound less than the boiler pressure, which was


B
A
A
C
A
A
B
12
Radius of 48 inc.
Radius of 46½ inc.
22
25
11
28
50
6 ft
24
11
30
16
A
15
9
35
13½ ft
8 ft
14
13
18
C

about the mean with wide throttle, as shown by indicator diagrams), and water as 941 to 1, there would be required to be evaporated 84·9 cubic feet of water to furnish that amount. Sea water weighing 64·3 pounds per cubic foot, the weight of water would be 5459·07 pounds evaporated per hour by 1027 pounds of coal, to which must be added the loss by blowing off, so as to maintain the saturation of the water in the boilers at $\frac{2}{32}$ of the ordinary hydrometer, equal to 11·93 per cent. of the total caloric imparted to the water; this would give an additional evaporation of 0·72 pounds, making a total evaporation of 6·03 pounds of sea water per hour per pound of anthracite coal: a rate of economical evaporation fully up to the ordinary standard of marine boilers.

With the above consumption of coal, there were burned per hour 12·83 pounds of coal per square foot of grate.

Each square foot of heating surface evaporated per hour 3·58 pounds of sea water.

Speed.—The mean speed of the *Bibb* at sea in ordinary weather was 7 knots per hour under steam alone, the wheels making 19 revolutions per minute; steam boiler pressure 15 pounds per square inch, cutting off at half stroke. Paddles dipping 42 inches. The circumference of the centre of reaction of the paddles was 46·34 feet. Taking the knot at $6082\frac{2}{3}$ feet, the slip of the centre of reaction of the paddles would be as follows:—

$46\cdot34 \times 19 \times 60 = 52827\cdot60$ ft. = speed centre of reaction of paddles per hr.
$6082\frac{2}{3} \times 7 = 42578\cdot67$ ft. = speed of vessel per hour.

$10248\cdot93$ ft. = slip of centre of reaction of paddles per hr.

or 19·4 per cent.

The loss of power by the oblique action of the paddles, calculated as the squares of the sines of their angles of incidence on the water, is 18·8 per cent.

The power actually developed by the engine when working with a total initial cylinder pressure of 28 pounds of steam per square inch, cutting off at half stroke, and making 38 strokes per minute; taking the back pressure on the piston at 4 pounds per square inch, would be as follows, viz:—

Including the effect of the expansion of the steam in the cylinder passages and clearance, the mean effective pressure will be 19·94 pounds per square inch of piston, and

$$\frac{2002\cdot96 \text{ (area of cyl. in sq. in.)} \times 174\tfrac{1}{6} \text{ (speed of piston in ft. pr. m.)} \times 19\cdot94}{33000},$$

= 210·8 horses power.

Allowing $1\frac{3}{4}$ pounds per square inch of steam piston for the power required to work the engine, overcome the load on air pump, &c., we have, say 8·3 per cent. of the power thus absorbed.

Taking the coefficient of friction from the experiments of Morin at 0·75 of the power applied, and taking the power applied upon the wheel to be the whole power developed by the engine, minus the power absorbed in working the engine, &c., the power absorbed by the friction of the load, will be, say 6·9 per cent. of the total power developed by the engine.

Collecting the above, we have the following disposition of the power in the *Bibb:*—

Slip of the centre of reaction of the paddles,	19·4	per cent. or	40·90	horses power.
Oblique action of the paddles,	18·8	"	39·63	" "
Working the engine, &c.,	8·3	"	17·49	" "
Overcoming friction of the load,	6·9	"	14·55	" "
Leaving to be utilized in the propulsion of the hull of the vessel,	46·6	"	98·23	" "
Totals,	100		210·80	

All the revenue steamers originally constructed with the Hunter wheel, had, soon after trial, either the common side paddle wheel or screw propeller substituted.

The experiment with the Hunter wheel, though totally valueless, except so far as proving experimentally the absurdity of that system of propulsion, which to any tyro in steam engineering needed no such proof, especially at such a cost as it was obtained, yet may prove valuable if it shall succeed in convincing others that although "all men are born equal in America," yet with a difference, and that gentlemen whose whole lives have been devoted to the study of the law, had better leave questions of engineering to professional engineers.

For the Journal of the Franklin Institute.

Notice of a new Steam Engine, Constructed by I. P. Morris & Co., Philadelphia, from Designs, and under the direction of FRANKLIN PEALE, *Chief Coiner of the Mint of the United States. (With a plate.)*

The general design of this engine, (Plate XII.) conforms to the Gothic or pointed style, and its construction is what is commonly known as the steeple engine, working by simple high pressure; there are, however, peculiarities, and as far as is known to us, novelties in construction, which it is thought are entitled to attention.

It will be observed on inspection of the engraving, that it is a combined or double engine, with the cranks at right angles; that it has no fly wheel, properly so called, but a pully or drum, from which the power is carried off by a broad belt (two feet in width). The drum is cast hollow, with chambers in the periphery, into which lead has been run, to counterpoise exactly, the pistons, triangles, pitmen, &c., so that the engine is in perfect equilibrium in every position, and performs its revolutions in an equal and regular manner.

It will be observed, also, that it is perfectly symmetrical in all views, and that there are no steam or exhaust pipes visible on the exterior. A heavy bed plate, serving as a base, of twelve inches elevation, supports the frame and cylinders; it rests upon a brick foundation laid in cement, and secured by strong bolts built in. The steam passages have been cast in the bed plate, to convey the steam to and from the chests and cylinders, which stand vertically upon it. The pipes which convey the steam from the boilers to the engine, are placed in a passage or chamber, built in the foundation, in which chamber the throttle valve, controlled by the governor, is placed.

The cylinders are placed eccentrically, within cylindrical cases, forming *jackets*, the intervening space, being the steam chest, containing the valve seats, and long slide valves, moved by the eccentrics, which are placed upon the shaft, immediately above; the eccentric position of the outer cylinder or jacket, allowing the required space on one side for the valve, and a sufficient space all round, for the channels and steam.

The cylinders are fitted over one another, with conical metallic joints, and the cylinder covers contain the stuffing boxes of the piston and valve rods.

It is this position and arrangement of double eccentric cylinders, giving space for the valves, channels, and steam, and forming a jacket round the working cylinders, which is claimed as an economic novelty, simple in its form, easy of construction, and presenting on the exterior a plain bright surface, an important security from loss of heat by radiation, or condensation of steam in the interior; and finally, entirely divested of the usual disfiguring appendages of steam channels, pipes, joints, &c.

The piston rods and guides are made of steel, the cross-heads travel upon the latter, with metallic packing of an approved alloy, with tightening screws. The pistons are furnished with what is termed steam packing, in other words, metallic plates, held against the surface of the cylinders by the pressure of the steam.

The triangles or stirrups, connected in the centre of the bow, with the piston rods, are forged in one piece, and are planed up, and finished bright throughout.

A simple solid pitman forms the connexion with the cranks, a double stub-end and strap connecting with the cross-head above, and a single one below, working on the wrist pin.

The shaft and drum are supported on two cast iron frames, which conform in general features to a pointed arch window, strengthened by pannels, and enriched by columns, supporting the pedestals, and carried up to a finial; its exterior being decorated with appropriate crockets. The two frames are connected above the drum, by stays and braces, which are consistent with the style, so arranged as to afford space, within which the governor stands, centrally and appropriately, to regulate the motion of all that is below and around it.

The engine is moved by steam at a pressure of eighty pounds, and is intended to be run at fifty revolutions per minute; this rate of motion is maintained without the slightest vibration, jar, or noise, and is calculated to give a sufficient effective force for all the heavy operations of the Mint. The power is applied, through the agency of belts, to the rolls, and other machinery, silently but efficiently, an evidence that in mechanics, as in moral science, the best effects may be produced with the least noise.

For the Journal of the Franklin Institute.

A Series of Lectures on the Telegraph, delivered before the Franklin Institute. Session, 1850–51. *By* Dr. L. Turnbull.

Continued from page 194.

Wheatstone and Cooke's Needle Telegraph.

In 1834, Professor Wheatstone published a beautiful series of experiments on the velocity of electricity, which I noticed in the first of these lectures on the Telegraph. This seems to have had an influence in directing his attention to the subject of the Electric Telegraph. During the month of June, 1836, in a course of lectures delivered at King's College,

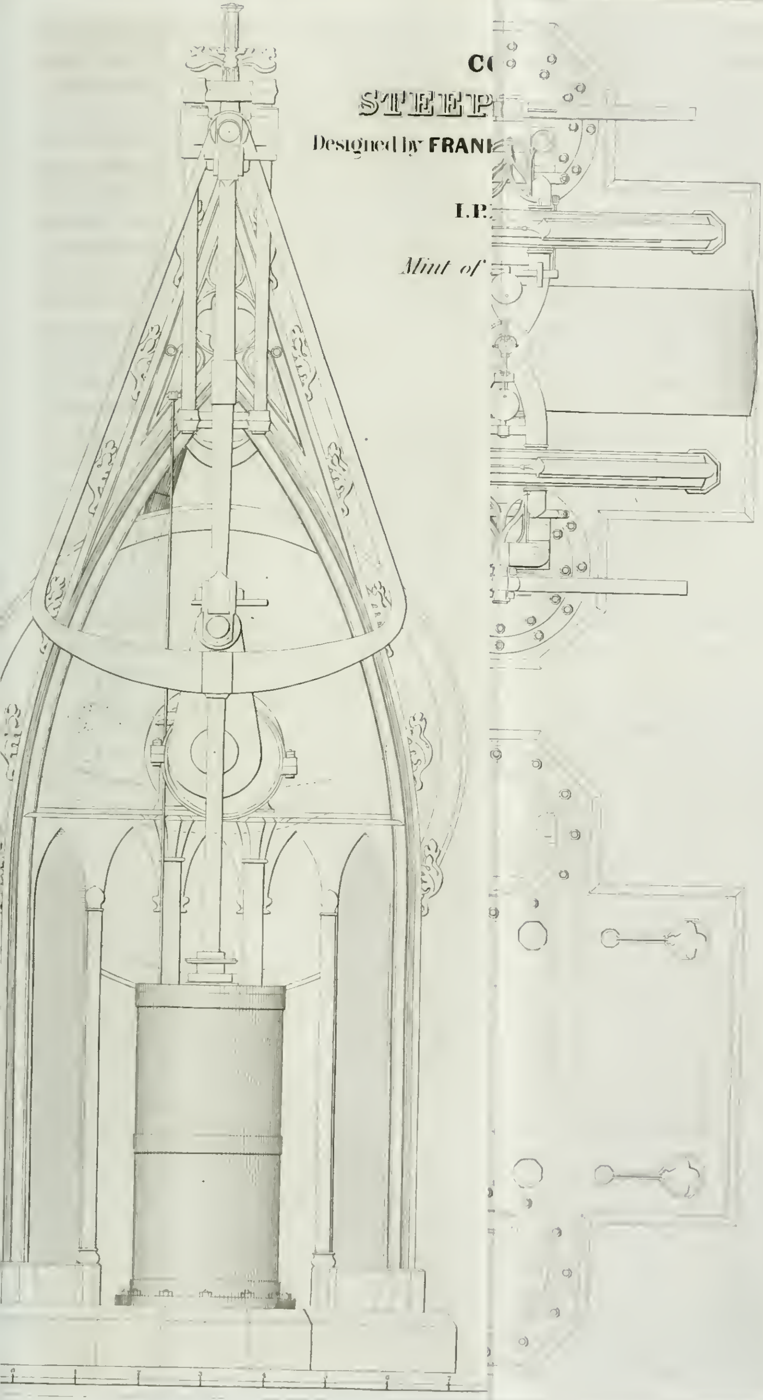
CO

STEEP

Designed by **FRANK**

I.P.

Mint of



COMBINED
STEEPLE ENGINE,

Designed by **FRANKLIN PEALE**, Chief Coiner,

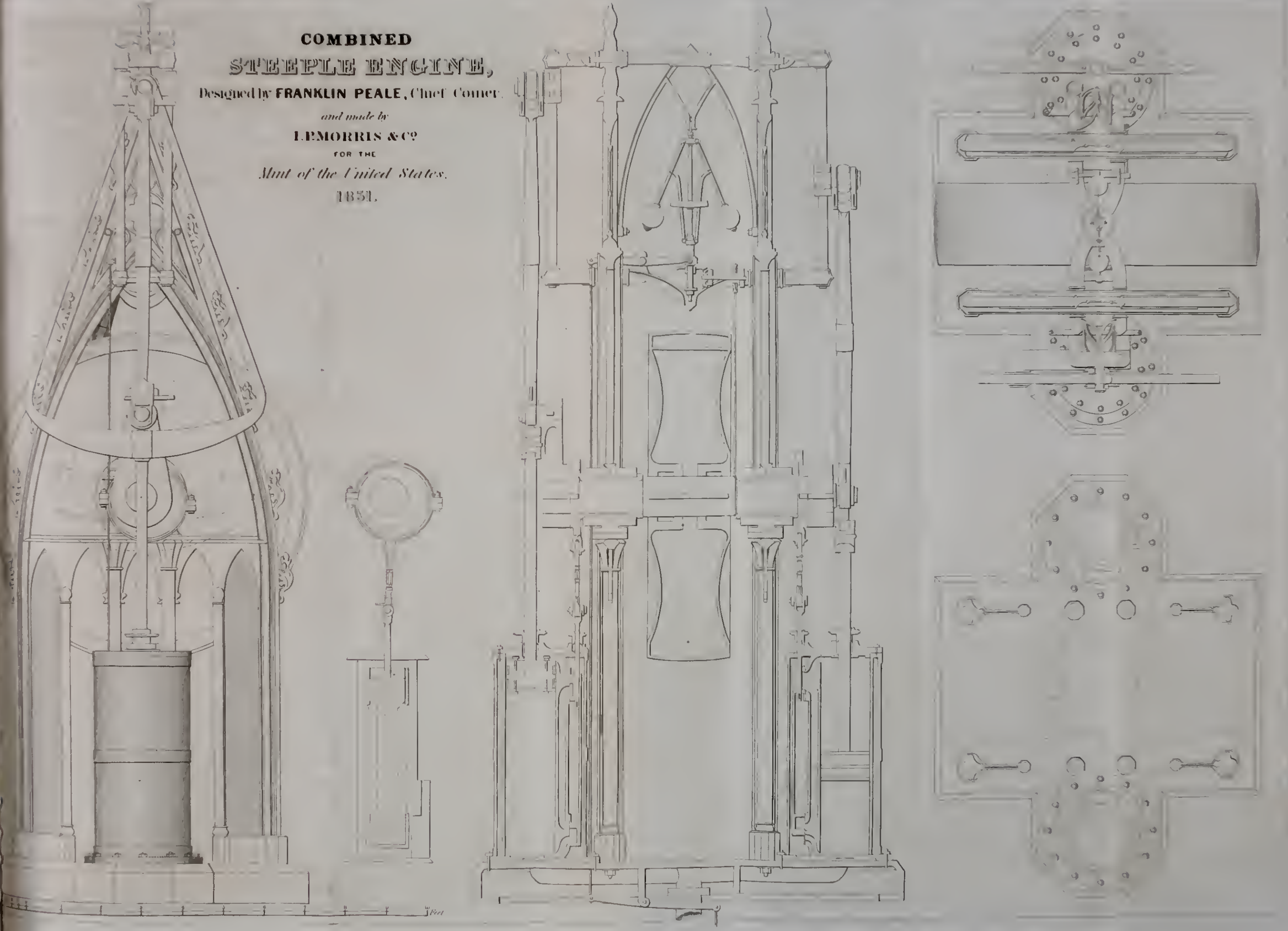
and made by

I. P. MORRIS & Co.

FOR THE

Mint of the United States.

1831.



London, he repeated his experiments on the velocity of electricity, but with an insulated circuit of copper wire, the length of which was now increased to nearly four miles; the thickness of the wire was $\frac{1}{16}$ of an inch.

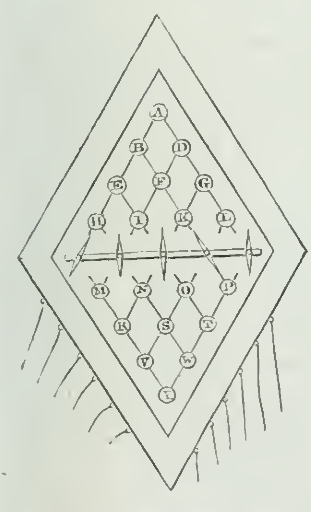
When machine electricity was employed, an electrometer placed on any point of the circuit diverged, and wherever the continuity of the circuit was broken, very bright sparks were visible. With a voltaic battery, or with a magneto-electric machine, water was decomposed, and the needle of a galvanometer deflected in the middle of the circuit. Prof. Wheatstone gave a sketch of the means by which he proposed converting his apparatus into an electrical telegraph, so that, by the aid of a few finger stops, it would instantaneously and distinctly convey communications between the most distant points. The apparatus, as it is at present constructed, is capable of conveying thirty simple signals, which, combined in various manners, will be fully sufficient for the purposes of telegraphic communication.—*Mag. Pop. Sci.*, 1836.

This was Prof. Wheatstone's first telegraph, and having matured his plans, he took out a patent on the 12th of December, 1837, which was sealed on the previous 12th of June, 1837, in conjunction with Mr. W. F. Cook, who had devoted much of his time and attention to the practical application of the Electric Telegraph.

The principle on which this telegraph depended, was that of combining several peculiarly constructed galvanometer needles. It was an application of the famous discovery of Professor Œrsted of the deflecting influence of an electric current upon a magnetic needle, which I have already explained in a previous lecture.

"A signal board was employed, having five vertical galvanometers with double needles, the lower ends of each being slightly the heaviest, so as to ensure at all times a vertical position, except when deflected by the current. From the ends of these needles lines were drawn, both above and below, as in fig. 32, and at the points where these lines intersected, letters and numbers were placed. When an electric current was transmitted so as to deflect at the same time two of the needles, they indicate, by their convergence, one or other of the letters marked on the signal board. Thus, if the first and fifth needles converged above, they pointed to A, if below, to Y; or if the first and fourth converged above, they indicated B, and so on.

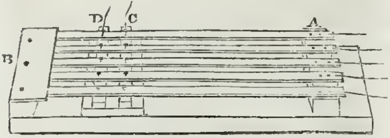
Fig. 32.



The signal boards were placed at either end of the line of telegraph, having a battery and keys so arranged as to render it easy to deflect at pleasure any of the five galvanometer needles at the distant station: the two sets of galvanometers being connected by six wires, one for each separate needle, and one as a return common to them all. The keys used to connect these wires with the battery were very simple, and at the same time perfectly efficient.

The arrangement consisted of five copper bars, thin enough to be elastic, fastened to a cross-piece of wood, as at A, fig. 33, and connected with the five wires of the telegraph, whilst their other ends pressed slightly, (but so as to be in good metallic contact,) against a cross-piece of copper, B. The terminal wires of the voltaic battery were attached to two small bars of metal, C D, and in the five longer bars, just where they crossed the battery bars, C D, there was a row of small metal pins, terminated with little ivory knobs. When it was desired to deflect any of the needles in the signal boards, all that was necessary was to press the ivory knobs above those bars, in connexion with the needles to be deflected; the slight pressure, by bending down the bars, insulated them for the time by breaking the contact at B; and the metal pins, by coming in contact with the cross bars C and D, became connected at once with the battery. By this simple arrangement the keys, though always ready for immediate use in sending a signal, were not any obstacle to receiving one, as the bar B, always completed the circuit of all the wires, except at the moment of using the telegraph, and then by the contrivance just described, it was thrown out of connexion. The wires of this first telegraph were insulated in tubes by means of a mixture of cotton and India rubber; then the prepared wires are all passed with certain precaution through iron pipes, which on some parts of the line were buried beneath the ground, and in others raised above it. It was afterwards elevated on wooden posts, as the moisture affected the wires, and destroyed the insulation. The battery employed by them was that of a vessel of copper, with plates of zinc, and acidulated water.

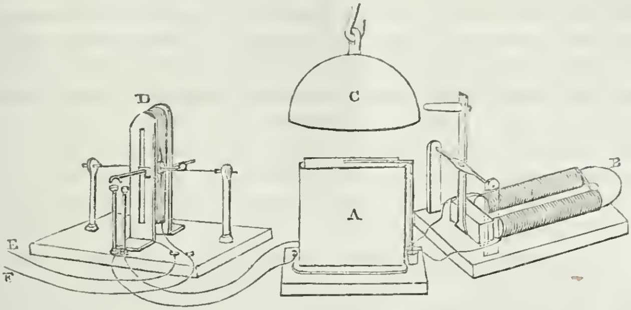
Fig. 33.



In order that the telegraph could be practically used, it was essential that some simple means should be employed to call the attention of the operator when a message was about to be sent, as the movement of the needles made no sound.

In order to overcome the difficulty presented by the very small amount of power which would be transmitted to a long distance, and which was not sufficient to make an electro-magnet of any power, and thus discharge an alarum, he placed a second battery at the distant station, having wires connected with a powerful electro-magnet attached to an alarum, or arranged so as to strike a bell as soon as the battery was brought into operation. But, as the circuit was broken, the battery, though charged with acid, and therefore ready to act, could not exert its magnetising power on the electro-magnet unless the circuit was completed. The current of electricity from the distant station from whence the intelligence was to be transmitted, though not powerful enough to make an electro-magnet, was abundantly powerful enough to complete the circuit of the second battery, thus waiting to be called into action. This was effected by a small piece of copper wire attached to a cross piece fastened to a delicately suspended vertical galvanometer; when the latter was deflected by even a feeble electric current, the copper wire, by having its ends plunged into two cups of mercury, completed the circuit of the secondary battery, causing the electro-magnet to attract its keeper, and thus let off the alarum to ring the bell. The general form of the arrangement is represented in Fig 34, which I have taken from a published lecture by Professor E. Solly of London, on the telegraph.

Fig. 34.



E F are the wires conveying the electric current from the distant station; D, the vertical galvanometer deflected by its influence; A, the secondary battery thus brought into action, and B, the electro-magnet which is made to act on the bell, C.

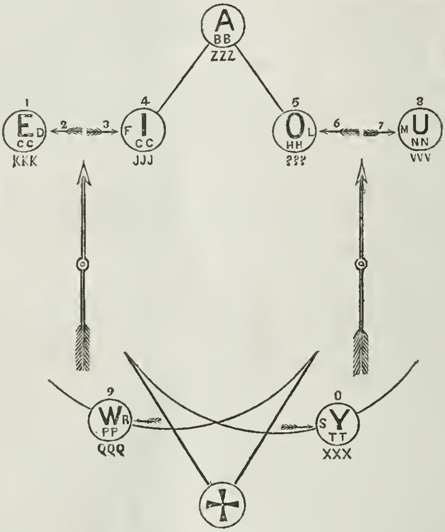
The line of telegraph upon the Great Western Railroad was finished in July, 1839, and had been in operation about seven or eight months. Thirty signals may be conveniently made in a minute. According to Professor Wheatstone, on his examination before a Parliamentary Committee on Railways in 1840, he states, "I have been confining the attention of the Committee to the telegraph now working on the Great Western Railway, but having lately occupied myself in carrying into effect numerous improvements which have suggested themselves to me, I have, conjointly with Wm. Cooke, who has turned his attention greatly to the same subject, obtained a new patent for a telegraphic arrangement, which I think will present very great advantages over that which at present exists. This new apparatus requires only a single pair of wires to effect all which the present one does with five, so that three independent telegraphs may be immediately placed on the line of the Great Western; it presents in the same place all the letters of the alphabet according to any order of succession, and the apparatus is so extremely simple, that any person without any previous acquaintance with it can send a communication and read the answer."

Mr. Saunders, the secretary of the Great Western Railway, states the expenses of constructing the electrical telegraph on the line of that railway to have been from £250 to £300 a mile; whereas, the old form of telegraph in use between London and Portsmouth, independent of the original outlay, costs about £3300 a year; and the lines of telegraphic communication to Plymouth, to Yarmouth, and to Deal, were abandoned in the year 1816, on account of the expenditure for their maintenance.—*Civ. Eng. and Arch. Jour.*

According to the *Tyne Mercury*, the electric telegraph on the South Western Railway, from London to Gosport, cost about £24,000.

Professor Wheatstone specified a second patent for improvements, in the name of Mr. Cook, Oct. 18, 1838, still making use of the deflexion of needles as the signals employed, and using only two wires instead of five, and a combination of the two elementary instruments. It has two pointers, each worked by its distinct handle, and gave eight single signals, and a sufficient number of compound ones to admit of the twenty-six letters of the alphabet being used. By further conventional signs those letters are made to represent figures; and by blending both systems, a mixed sentence, consisting of passages from a code, spelling and figures, could be telegraphed together. The general form of the dial is shown in Fig. 35. Behind this dial a magnet is fixed on the same axis as the needle, so that both move together. A portion of the conducting wire is coiled many times longitudinally round a frame in which the magnet moves; by this contrivance, the magnet is subjected to the multiplied deflecting force of the voltaic current. The motion of this magnet is limited by fixed stops placed at both sides. The simple signals are given by the movement of the needles, either singly or combined. Thus the left hand needle moved to the left gives E, to the right I: the right hand needle moving to left gives O, and to right gives U. If both converge upward at the same time, their combined indication is A, and if they converge downwards it is +. If the pointers are made to rest parallel to each other in one direction, W is meant, and in the other direction they indicate Y. The consonants most in use are given by two movements of the needle, and those rarely required, such as J Q X Z, by three movements. C and U are generally used for K and V, but not necessarily.

Fig. 35.



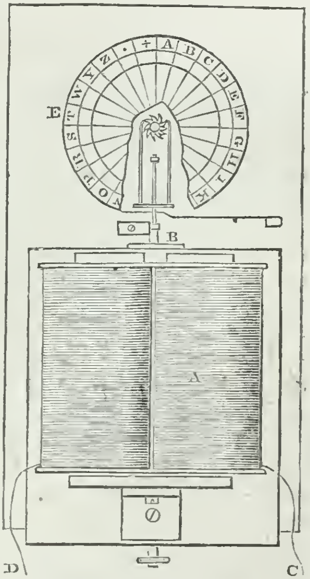
Wheatstone's telegraph cost per mile £100. (*Mech. Mag.*, 1838.) This telegraph, which is the useful and scientific invention of Mr. Cook and Professor Wheatstone, has now been in operation for nearly twelve months; all the wires are enclosed in hollow tubes, not more than about an inch in diameter.—*London Mining Journal for* 1840.

The American patent for Electro-magnetic Telegraph, Charles Wheatstone and Wm. Fothergill Cook. Patent for fourteen years from 12th June, 1837, that being the date of the English patent.—*Franklin Inst. Jour., Third Series, Vol.* II. *p.* 120, *August*, 1840.

The American patent was of no benefit to the patentees, as it was never practically employed in the United States, Prof. Morse's instrument being the chief one in use from 1844 to 1846.

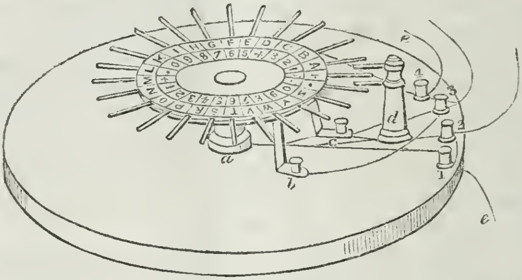
The defects in the practical working of his first and second telegraph led Prof. Wheatstone to devise a new form of telegraph, called by him an electro-magnetic telegraph, in January, 1840. The principles employed in this new instrument are well exhibited in Fig. 36 (*Daniells' Elements*). "It consisted essentially of an electro-magnet surrounded with a long and fine wire, A, and a keeper of soft iron, B, prevented from coming in complete contact with poles of the magnet, but so near as to be within reach of the attractive power of the magnet when the latter is under the influence of the current.

Fig. 36.



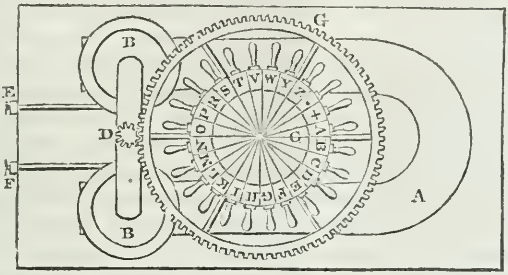
The motion of the keeper was made use of in various ways to communicate signals. In Fig. 36 it is represented as acting by a species of clock escapement on a small ratchet wheel, and thus causing the rotation of a light disk of paper or mica, E, on the circumference of which the letters of the alphabet, or other signals, are marked. In the diagram, part of this disk is represented, which resembles very much the signal dial of Mr. Ronalds, and is on the same plan. It is in part cut away to show the position of the ratchet wheel behind. The ratchet wheel resembles one invented by Burgengeiger, a German, to which he had attached an electric clock, as described in the *Morgan Blatter*, of September 23, 1815, and quoted by Mr. Ronalds in his work on electricity, published in 1825. Every time that an electric current is transmitted from a distance by the wires C D, and they may be made to succeed each other with great rapidity, the disk is advanced one tooth of the wheel, and consequently another letter; and when the electric current is interrupted, the keeper being no longer attracted, is drawn up again to its original position by a spring, and the disk advanced another letter. The whole instrument is inclosed in a case, having an aperture in front, which only permits one letter at a time to be seen. In using this telegraph, the instrument is always placed at the commencement with the sign of a cross only visible, which is before the letter A, on the round disk; if it is then wished to indicate the letter H, it is necessary to transmit four separate electric currents, in order to attract the keeper four times, and so cause the disk to move round eight divisions, the letter H will be exhibited. The transmission of the currents is managed by a little instrument represented in Fig. 37. It consists of a horizontal brass wheel, divided and marked on its upper surface like the disk of the telegraph, with which it perfectly corresponds; the circumference of this wheel is cut away in twelve places, and filled with small pieces of ivory. A metallic spring, *b*, pressing against the circumference of the wheel, is alternately in contact with the metal of the brass wheel and the ivory pieces when the wheel is turned round. When the instrument is not in use, the cross at the commencement of the alphabet is always placed opposite to the stop *d*, as in this position alone the metallic spring, *c*, by pressing on a small piece of metal connected with the stand *a*, cuts off the connexion with the battery, and therefore leaves the telegraph in a fit state to receive signals from the distant station. As soon as the wheel is moved from this position, the battery is brought into connexion, and as it is gradually turned round, the required number of interrupted currents is transmitted to the magnet. In the circumference of the brass wheel a number of iron pins are inserted, one corresponding to each letter, and, therefore, by taking hold of the pin corresponding to the letter we wish to indicate at the distant station, and rapidly turning the wheel till stopped by the cross piece at *d*, we cause the letter disk of the telegraph to revolve the required amount.

Fig. 37.



The preceding is one of the simplest forms of this telegraph, but the power is applied in many ways; thus, in place of moving the letter disk it may remain stationary, whilst a light hand or index only, is caused to revolve; or in place of an electro-magnet being used, the mere deflexion of a vertical galvanometer may be employed for the same purpose. But as it was found that a telegraph of this kind, though excellent for short distances, was not so suitable for long ones, a modification was adopted, in which the power required was greatly diminished, and the delicacy of the telegraph much increased. In this form a powerful clock movement, acted on by a strong spring, was employed to rotate the disk or index, the attraction of the keeper being only used to regulate the escapement, every current releasing a single tooth, and so allowing the clock movement to advance the disk one letter. He employed a magneto-electric machine instead of the battery, also doing away with the "communicator." Fig. 38 shows a vertical representation of one of the machines used for this purpose, consisting of a permanent magnet, A, an armature of soft iron, B, surrounded with coils of copper wire, and connected with the binding screws, E F. The armature can be made to revolve by the action of the larger wheel C, on the pinion D, which is thus caused to revolve just so many times by one revolution of the wheel C, as will give rise to the number of currents requisite to turn the telegraph disk once round. The whole of this instrument is inclosed in a box, and the axis of C, which rises through the top of the box, carries a solid brass wheel, G, having handles corresponding to the letters of the alphabet, and signals of the telegraph disk. I extract from the *London Artisan*, *Vol.* iii. *p.* 247, *for Nov.*, 1849, an account of the present condition of this telegraph in England, by Francis Whishaw, Esq.

Fig. 38.



The construction of the telegraphs, chiefly used in England, may be thus described:—Along the sides of the various railways (for by this system it is wise to have the telegraph wires protected, as far as possible, by a constant supervision) wooden vertical posts of fir timber are ranged at convenient distances. Each post is furnished with an insulator of earthenware, through which the wires are drawn, to prevent their connexion with the wooden posts. The wires are of stout galvanized iron, which are carried from one end of the railway to the other, except in passing through tunnels, or under bridges. In such cases, the insulators are attached to the brickwork; and thus the wires are prevented from being in contact with the brickwork. Each post is furnished with a lightning conductor, and is also capped with a wooden roof, with dripping eaves to throw the rain water from the wires. At each end of the telegraphs, the line wire is connected with an earth battery, consisting of a large plate of zinc or copper, buried in the earth—the object of which is to avoid the necessity of a return wire, which in the first telegraphs in England was made use of. At the various stations, one or more of Cooke and Wheatsone's needle instruments are set up, and which are connected with the line wires and batteries by wires of smaller size, generally covered with silk or cotton, which is easily destroyed by the alterations of weather, and, therefore, is objectionable. Each telegraph on this plan has two wires. The batteries used are of the most simple form, consisting of a trough, divided into any number of cells, according to the power required. Alternate plates of zinc and copper are connected throughout the pile, which dip into sand, saturated with dilute sulphuric acid—the use of the sand being to prevent waste of the acid in the battery, when required to be sent from one station to another ready charged. The signals are given by means of the needles, placed in front of a dial, on which are written or engraved, the letters of the alphabet, being moved either to the right or to the left. Each needle in *front* of the dial is placed on the same axis as a magnetic needle *behind* the dial, which latter is suspended freely in a space, surrounded by a coil of wire, through which coil, when the current is transmitted either in one direction or the other, the needle is deflected either to the right hand or to the left, as may be desired; so that, by a certain number of movements of each needle, and by the combination of the movements of both, every letter of the alphabet, or any numeral, is given. As many as thirty letters, under ordinary circumstances, are thus transmitted in a minute; but by expert manipulators many more. Although the requisite movements are easily learned, yet it requires many weeks for a telegraphist to work the needle instrument sufficiently well to be entrusted with a communication of any value, whether for railway or commercial purposes; moreover, it is requisite that the two persons communicating with each other should be equally advanced in the required manipulations. Some of the boys employed by the Electric Telegraph Company, have acquired wonderful rapidity in the transmission of messages; while I have known many persons give up the occupation altogether, although having no other employment to resort to. In case of a telegraphist attending the needle instrument being suddenly disabled by illness or otherwise, great inconvenience must be experienced, by reason of no one being at hand to take his place; whereas by other instruments, as that of Siemen's, &c., which can be worked by man, woman, or child, at five minutes' notice, this inconvenience is done away with. The exposure of the wires to atmospheric influence—to storms of snow, as lately experienced on the South Eastern Railway—to the destructive effects of trains running off the way, and to the destruction of the wires by malicious persons (rewards for whose apprehension have frequently been offered), are all fatal objections to the present English system ever becoming universal. Moreover, the expense to railway companies and others is a sad drawback to the further extension of this system in Great Britain and Ireland—for the railways of which alone an extension of at least 2000 miles is still required. The average charge for an electric telegraph, with two wires, as hitherto furnished to the various railway companies in England, may be stated at not less than 150*l.* per mile; added to which an annual sum must be calculated on for keeping it in order, and reinstating, when necessary, the wooden posts, &c. The charge for transmission of communications by the Electric Telegraph Company's telegraphs in England, is at the rate of one penny per mile for the first fifty miles, and one farthing per mile for any distance beyond one hundred miles. The South Eastern Railway Company's charges for telegraphic communications are even much higher than those of the Electric Telegraph Company. Thus twenty words, transmitted eighty-eight miles, is charged the large sum of 11s.; whereas the same length of communication for the distance of 100 miles is only charged 6s. 3d. by the Electric Telegraph Company.

If we judge by the following remarks, some of the English journals appreciate the advantages of this form of telegraph.

"We have heard of things being done 'in less than no time,' and always looked on the phrase as a figure of speech signifying great despatch. The paradox seems, however, to have been actually realized in the invention of Wheatstone's Great Western Telegraph, a message having been sent in the year 1845, and received in the year 1844! It appears that directly after the clock had struck twelve, on the night of the

31st of Dec. last, the superintendent at Paddington, signalled to his brother at Slough, that he wished him a happy New Year; an answer was immediately returned, suggesting that the wish was premature, as the New Year had not yet arrived at Slough. Such, indeed, was the fact, for 'panting' Time was matched against the telegraph, and beaten by half a minute."

On the London and Portsmouth Electric Telegraph, (88 miles,) "Her Majesty's speech, on the opening of Parliament, was transmitted by the telegraph to Portsmouth, and published there almost as soon as in London. The speech contained 3600 letters, and was printed off as it arrived. It occupied about two hours in the transmission, being at the rate of about 300 letters per minute.—*Mech. Mag. Feb.* 1, 1845.

By the following decision of the Judicial Committee of the Privy Council, it will be seen that Messrs. Cook and Wheatstone were refused an extension of their patent, on the ground of their having been "sufficiently remunerated, and that the Electric Telegraph had not been so poor an investment as we have been led to believe by the English Press," as the share-holders have received a bonus of £15 per share, besides the usual dividend of 4 per cent. on £300,000.

"The Electric Telegraph Company sought to obtain the prolongation of letters patent which had been granted to William Fothergill Cooke and Charles Wheatstone on the 12th of June, 1837. The books of the petitioners were made up, it appeared, and balanced to the 31st December, 1850, and the subjoined statement will show the receipts and disbursements of the petitioners since the introduction of the electric telegraph:

Receipts from the railway companies for their use of the company's patents,	£122,285	13	2			
Receipts from maintenance and sundries,	7,301	13	1			
				£129,587	6	3
In addition to the foregoing, the company have received gross profits on the erection of telegraphs for railway companies amounting to				40,747	4	2
				£170,334	10	5
Less charges, including part of the law and parliamentary expenses,				34,319	6	7
Making the total receipts,				£136,015	3	10
Total amount paid for patents,				£167,688	9	0
Showing that, after crediting the patent account with the above mentioned amount of £40,747 4s. 2d. received for erections, the total payments have exceeded the total receipts by				31,673	5	2
The Company have in their books charged the capital account of their commercial telegraph with £33,603 10s. 8d. as the estimated value of the patent employed therein. If this nominal charge be added to the amount of actual receipts, as above stated, the patent account will then show an apparent surplus for all patents of				1,930	5	6
The commercial telegraphs have yielded during the three years which have elapsed since the commencement of their working a total gross return of	£103,444	7	11			
At charges amounting to	83,265	6	11			
Showing a surplus of				20,179	1	0

Which surplus of 20,179*l.* 1s. is the total nett return upon a capital of 104,229*l.* 17s. 8d.—the actual cost, but much more than the present value of the patent—the amount actually expended in the erection of the commercial telegraphs; or upon a capital of 137,833*l.* 8s. 4d. if the patent account is to have the benefit of the above nominal charge of 33,603*l.* 10s. 8d.

The evidence which was adduced in support of the petitioners' case was chiefly directed to show the reasonable charges made by the company, and the accuracy of the accounts.

Their Lordships decided that, as the patentees themselves had been sufficiently rewarded, the company—who derived their right from them—had no *locus standi*, and therefore refused the application.

To be Continued.

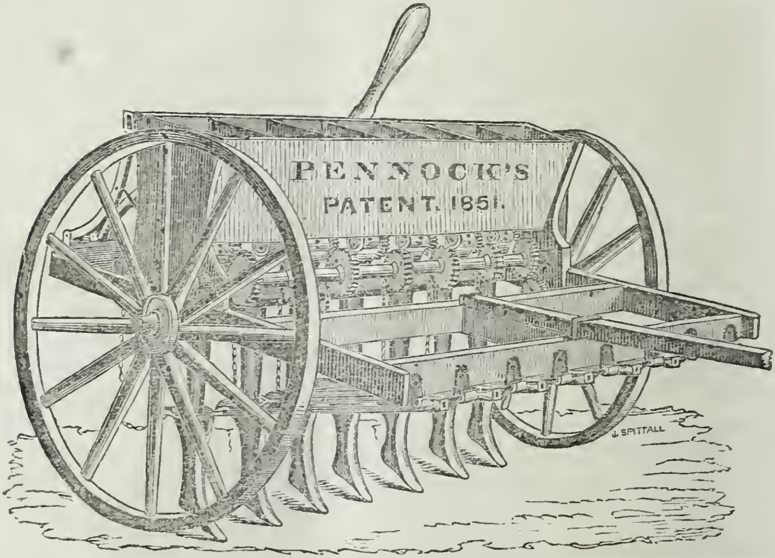
For the Journal of the Franklin Institute.

Description of Improvements in Seeding Machines. Patented by S. & M. PENNOCK, *Kennett Square, Pennsylvania, July 8th,* 1851.*

Fig. 1 represents the Pennock Drill, as last improved.

Fig. 2, is a sectional view of the same. Figures 3 and 4 represent the cylinders for distributing the grain. Figures 5 and 8 represent the improved depositing tube shown in fig. 2. Figures 6 and 7 are modifications of the same. The same letters on different figures represent the same parts. In fig. 2, A is the seed hopper; B, cog-wheel upon the end of the seeding cylinder; C, an intermediate wheel, by which motion is imparted to the seeding cylinder, B, from the cog-wheel D, which is fixed on the axle of the machine. E, a leathern tube to conduct the

Fig. 1.



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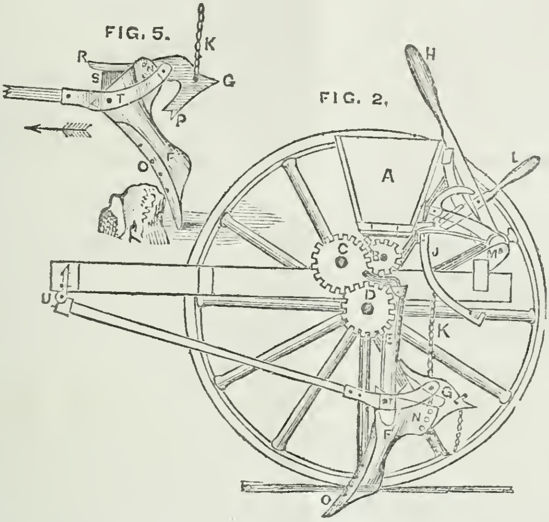
* See page 101.

grain from the cylinder B, into the iron depositing tube, F; G, a self-adjusting lever; H, a handle by which the entire machine is thrown out of gear; L, a lever by which the entire machine is thrown into gear; J, the handle for starting and stopping each row separately; *a* and *c* are sections of the cylinder, or cylinder caps, the proper thickness for the depth of the seed receptacles; *b* is an oblique projection cast upon the periphery of a plain ring, forming the bottom of the seed receptacles.

FIG. 5. FIG. 2.



The projection, *b*, is fixed to its place against either the *a* or *b* section of the cylinder, by a screw entering it through the end of the cylinder cap, against which it is fixed.

FIG. 7. FIG. 6. FIG. 8.

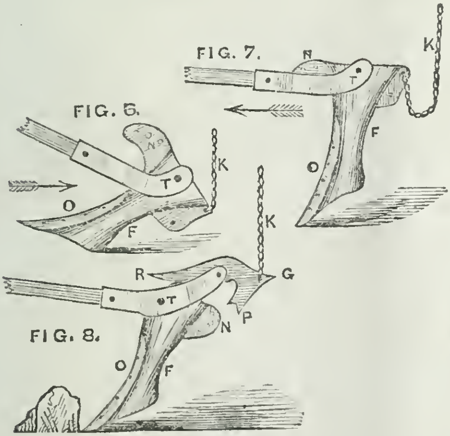


FIG. 3.

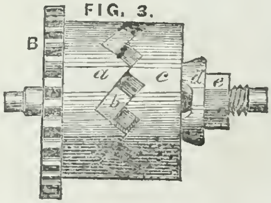
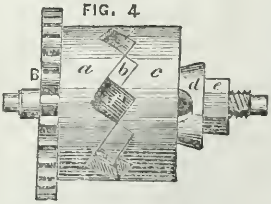


FIG. 4



To adapt the cylinder to seeding wheat, rye, or smaller seeds, the projections *b*, are to be confined to the cap, *a*, as in fig. 3, forming 12 medium sized seed receptacles. For planting corn, oats, or other large grain, the projections, *b*, are attached to the cap, *c*, by changing the screw to that end of the cylinder, thus forming but six large seed receptacles, as in fig. 4.

The seed receptacles may be varied in size at pleasure, by simply loosing the screw nut, *e*, from against the washer, *d*, which is of such a peculiar form as to throw the line of bearing at right angles to the contiguous obliquities of the teeth upon the caps *a* and *c*.

The depositing tubes are suspended in a forked bar by side bearings at T. N, are three holes in which a wooden pin is inserted to secure the depositing tube in its proper position, said pin being intended to break and allow the point of the depositing tube to turn backward when it comes in contact with a rock, root, &c., whilst the machine is in motion.

The depth to which the grain is deposited is regulated simply by changing the said pin from one of the holes, N, to the other. In figures 6 and 7, the pin rests on the top of the drag-bar, and must invariably give way when the point of the tube comes against a fixed obstruction; while in figs. 5 and 8, the lever, G, is made to relieve the pin (upon which it bears at P), when approaching rocks, &c., by tightening the chain, K, as in fig. 8, allowing the point of the tube to turn backwards and pass over the obstruction, as in fig. 5, without damaging said point. When the tube has passed the rock, it falls forward of its own weight, drawing the point R, of the lever, G, down upon the cam, S, holding it in its proper place, as in fig. 5, until the chain, K, is loosed, when the lever, G, again falls with its notched end, P, upon the wooden pin, and the machine moves on without detention. Another great advantage possessed by Pennock's patent depositing tubes over others, is the impossibility of clogging or damaging them when the horses set, or run backward with them in the ground, the arrangement being such as to allow them to turn forward, as in fig. 6. Each depositing tube is provided with a point, steel plate, O, which is not only reversible, but either of its points may be extended several times as they become worn.

These plates alone are a saving to the farmer of from $12 to $15; so each sell. The hinge joints W and T, are both of such peculiar construction as to admit of removing the drag-bar from the frame of the machine, and the depositing tube from the drag-bar, without the use of any kind of mechanical improvement, or without loosing a screw.

Opinion of JUSTICE CRESSWELL, *in the Case of The Electric Telegraph Company vs. Brett and Little.**

Judgment delivered by Mr. Justice Cresswell as follows:—This was an action brought by the plaintiffs against the defendants for the infringement of a patent. The patent was granted in 1837 to Messrs. Cooke and Wheatstone, for "improvements in giving signals and sounding alarms in distant places, by means of electric currents transmitted through metallic circuits," and was afterwards assigned to the plaintiffs. The action was tried at the sittings after Hilary term, 1850, before Lord Chief Justice Wilde, and a verdict was then found for the plaintiffs; and

* From the London Railway Magazine, No. 621.

in answer to certain questions put to the jury by the learned judge, certain special matters were found, on which the defendants had leave to move to enter the verdict for the defendants. A rule *nisi* was accordingly obtained, to which cause was shown; and in the argument the chief question raised was, what was the proper verdict to be entered in respect of the special matters found by the jury in answer to the questions of the Lord Chief Justice. To the third question, which was material, the jury found that the magnetic ring and indicator of the defendants was a different instrument from the needle claimed in the specification of the plaintiff's patent; and they also found, in answer to the fourth question, that "the sending of signals to the intermediate stations was new to the plaintiffs," by which expression was to be understood that it was a new invention of the patentees. The jury also found, in answer to the fifth question, "that the angular motions of the needles in vertical planes or horizontal axles, conjointly with the stops, was new to the plaintiffs," meaning that it was a new invention of the patentees. In answer to the sixth question, they found, "that as a whole the defendants' system of communicating with one wire and two needles was not the same as the plaintiffs'." It was insisted by the plaintiffs on showing cause, that on these findings they were entitled to retain the verdict in respect to the answers on the fourth and fifth questions. It appeared that the defendants, by means of duplicate coils and apparatus at the intermediate stations, had sent signals to all the intermediate stations, as well as between the terminal stations, and that they used an instrument moving in a vertical plane, called "a magnetic ring and indicator," producing nearly the same result as the needle described in the plaintiffs' specification. The jury, however, having found that the magnetic ring and indicator was a different instrument to the needle used by the plaintiffs, the defendants insisted that their use of it was no infringement of the plaintiffs' patent. The objection, however, mainly relied upon, was, that the plaintiffs' specification protected only the patentees' improvements as applied to metallic circuits, and that if the electric current was transmitted by improved machinery, not by a circuit wholly metallic, the improvements might be used without an infringement of the patent. The defendants using the earth to complete the circuit of the electric current, did not use a metallic circuit, and, therefore, they denied that the use of the plaintiffs' other improvements was an infringement of the patent. This was a grave objection, but the Court was of opinion, after full consideration, that it ought not to prevail. At the time of the grant of the patent the transmission of electric currents through metallic circuits was known, and also that the power of the current might be increased by coils in the wire. The discovery that the earth would complete the circuit of the current between the two ends of the wire struck into the ground, was made after the grant of the patent. The patentees did not, therefore, claim the invention of metallic circuits, but only improvements in the method of using electric currents—the currents being transmitted by a means open to the public. The circuit used by the defendants, so far as it operated in giving signals, and in all the parts to which the plaintiffs' improvements applied, was metallic: and it was not a necessary condition that the residue of the circuit should be metallic. The specification which claimed and described the invention was to be more strictly construed than the title of the patent, and the Court thought that the specification sufficiently comprehended all circuits that were metallic, as far as it was material to the improvements claimed that they should be so. And with regard to the use of the term, "metallic currents," in the title of the patent, the Court thought the title gave sufficient notice to any person acquainted with the discovery, or who had invented similar improvements to the patentees', to put him on his guard as to the nature of the plaintiffs' patent, and lead him to enquire how far any contemplated improvements would infringe it. The Court thought it but reasonable to hold that a claim for a patent for improvements in the mode of doing something by a known process, was sufficient to entitle the claimant to a patent for his improvements, when applied either to the process as known at the time of the claim, or to the same process altered and improved by subsequent discoveries. The next objection was, that the plaintiffs' patent was for a system of giving signals by means of several wires and converging needles pointed to certain letters, whereas the defendants used one wire, and made signals by counting the deflexions of the needle, which was found by the jury to be a different system. The Court thought this objection founded on a wrong discussion of the specification, which showed the patent to be not for a system of giving signals, but for certain distinct and specified improvements comprehending those now in question. The Court, therefore, thought the objections ought not to prevail to the grounds on which the plaintiffs claimed the verdict in respect to vertical needles and of the use of duplicates at intermediate stations. It might be doubtful whether the plaintiffs could claim the verdict with regard to the use of vertical needles by the defendants, considering the finding of the jury; but the Court thought that the use of duplicate apparatus at the intermediate stations, which the jury found to be a new invention, and which undoubtedly the defendants had used, entitled the plaintiffs in this respect to keep their verdict. If, however, the defendants' discovery enabled intermediate stations to send as well as receive signals, that was a very important improvement, for which the inventor might probably be entitled to a patent, though he might not be entitled to use it except by the license of the patentee of the less perfect invention on which the latter invention was grounded. For these reasons the Court thought the plaintiffs entitled to retain their verdict, and the rule must be discharged.—Rule discharged.

Opinion of Judge Kane, delivered before the United States District Court, Pennsylvania, in the Case of Detmold vs. Reeves, on a Motion for an Injunction, September, 1851.

This is an application for a special injunction to restrain the defendants from further violating the complainant's patent.

The complainant, Mr. Detmold, is the assignee, and as such, the patentee in this country of an invention made by Mr. Faber du Faur, and patented by him in 1840 and 1841, in Bavaria and Wurtemburg. The American patent was issued in 1842, but it was amended and re-issued in 1845. It is for "a new and useful invention for generating and applying heat;" and its immediate subject is a new mode of collecting, conducting, and using the combustible gases that ordinarily escape from the tunnel head of the blast furnace. The defendants are extensively engaged in the manufacture of iron, and it is charged that they are availing themselves of a part of the patented invention.

The interests which are involved in the controversy are very large, and may be seriously affected by the action of the Court on the present motion. The argument, therefore, has had the widest range—embracing the originality of the patented invention, its practically useful character, its identity in principle with the apparatus employed by the defendants, the right of the inventor and his assignee to protection under the Patent Laws, the regularity of the proceedings of re-issue, and their legal effect, as well as the policy of postponing the summary relief, which it is the province of equity to administer, until after an adjudication of the merits by a Court of Law. But of these questions, which were argued by the learned counsel on both sides with characteristic ability, there is only one, after all, which, on a careful review of the whole ground, I deem it necessary to decide.

The claim of the complainant, as it has been expounded by his counsel in the present case, is for "a new method of economizing fuel, by using the waste combustible gases of the upper portion of the blast furnace, by drawing them off below the upper level of the charge, and conducting them through convenient passages to other fire-places or structures, there to be burned as fuel." It does not assert an exclusive right to the use of gases from the tunnel head, nor to the employment of pipes or tubes for conducting gases; and very properly, for both of these were long ago familiar to the arts: its essential characteristic is, that the gases are to be withdrawn "below the upper level of the charge."

Can such a claim be legitimately deduced from the terms of the patent before me? This is the controlling question of the cause.

The descriptive language of the specification does not designate, as the place for taking off the gases, a point "below the level of the charges;" an expression that would apply equally well to any and every such point; but one, "at or near that point of the furnace, where the lime stone employed as a flux is completely calcined, and the reduction or deoxydation has not yet commenced;" and this point, it adds, "will generally be at about one-third of the height of the whole furnace below the tunnel head, or two-thirds above the bottom stone."

It is true, that the formal claim at the close of the instrument speaks of drawing off the gases at "one or more points below the top of the fuel;" and if the expressions *fuel* and *charges* can be regarded as convertible, this would certainly countenance the exposition of the complainant's counsel. But it does not stand alone; and it cannot be interpreted fairly without giving effect to the words that follow it: "substantially as set forth in the above specification." There is then an important qualification of the broad language of the claim;—one that limits and defines it by a reference to the description that has gone before;—and when the two parts are taken together, as they must be, they do not import the withdrawal of the gases from below the top of the charges generally, at any and all points whatsoever; but specially from at or near that point below the top of them, at which the flux has been calcined, and the deoxydation is about to begin.

The explanatory or practical reference, which is added in the specification, to a point one-third below the top of the furnace, makes this even more plain. For the indication of a point, ascertainable by simple measurement, as the one that will in most cases conform the structural arrangement to the rule deduced from scientific principle, is almost a declaration in terms, that the patentee had in view a *particular* point, and did not mean to apply his claim to all points below the charges alike.

So far, then, as the motion for an injunction asserts as its basis, that the defendants are using a device which has been specifically described and claimed in the patent, it cannot be sustained; since it is conceded that the defendants do not take out the gases "at or near the point at which the calcination is perfected, while the deoxydation has not yet begun;" nor at or "about one-third of the height of the tunnel," measured from the top. But the question still remains, whether the defendants are not violating the patent substantially; deriving from it information essentially connected with its subject matter; and only so far varying their structure in form and proportion as to elude its terms.

There is no doubt, that he who has discovered some new element or property of matter, may secure to himself the ownership of his discovery, so soon as he has been able to illustrate it practically, and to demonstrate its value. His patent, in such a case, will be commensurate with the principle which it announces to the world, and may be as broad as the mental conception itself. But then, the mental conception must have been susceptible of embodiment, and must have been in fact embodied in some mechanical device or some process of art. The abstract must have been resolved into the concrete. The patent must be for a thing, not for an idea merely.

This limitation, it may be said, denies to some of the more important products of mind, what it concedes to others of lower grade. But it is not the less true on that account. Men may be enriched or made happy by physical as well as by moral or political truths, which, nevertheless, go without reward for their authors. He who devised the art of multiplication could not restrain others from using it after him, without paying him for a license: The miner who first found out that the deeper veins were the richer in metal, could not compel his neighbor to continue digging near the surface.

The more comprehensive truths of all philosophy, whatever specific name we give to it, cannot be specially appropriated by any one. They are almost elements of our being. We have not reasoned them out perhaps, and may even be unconscious of their action; yet they are about us, and within us, entering into and influencing our habitual thoughts, and pursuits, and modes of life, contributing to our safety and happiness; and they belong to us as effectively as any of the gifts of Heaven. If we could reach the laws of nature, they would be, like water and the air, the common property of mankind; and those theories of the learned, which we dignify with this title, partake, just so far as they are true, of the same universally diffused ownership. It is their application to practical use, which brings them within the domain of individuals; and it is the novelty of such an application, that constitutes it the proper subject of a patent.

But the contract of the public is not with him who has discovered, but him who also makes his discovery usefully known. If he has discovered much, and discloses little—if there has been revealed to him one of the *arcana* of nature, and he communicates to the world only some one or more of its derivative and secondary truths, he patents no more than he has proclaimed. He will not be allowed afterwards, when the extent of his right shall be the subject of controversy, either by expanding into a general expression what was limited before in a particular form, or by tracing out for us the line that leads back from consequences to their remoter cause, to initiate us inferentially into the radical mystery of his invention, and then argue that he had described it by implication from the first, and so claimed ownership of it in his patent.

If, as it has been contended with great apparent force, M. Faber du Faur was really the discoverer of the true theory of the Blast Furnace, so as to determine from it the point at which the carbonic oxide, having performed its chemical function, might be withdrawn without sensible injury; if he knew that the gases, when taken from openings nearer the boshes, were capable of more intense combustion, but that their withdrawal so low down impoverished the action of the furnace, and that when used at the tunnel head, after they had performed successively the offices of deoxydating the mineral, calcining the flux, and vaporizing the water of the charges, they were less available as fuel in consequence of their increased impurity;—and, if knowing this, he had taught the iron master how to choose the best place for withdrawing the gases, having reference to the dimensions of his furnace, and the different sorts of fuel and mineral and flux employed in it, and with reference also, perhaps, to the purpose for which the flame of the gases was to be applied after they had been withdrawn;—no one can doubt that he would have conferred a signal benefit upon the arts of the world. And if he had, besides this, devised some form of structure, some material arrangement, by which his discovery might be applied to use, I would be most reluctant to say, that his patent, properly drawn out, should be limited to the mere mechanical illustration, and could not cover effectually the whole ground of his discovery.

But M. Faber du Faur and his assignee, Mr. Detmold, have not done this. They have announced no new principle of science, no natural law. They indicate to us the place at which the gases should be taken out, first, by reference to a scientific problem, which they leave unsolved, and next, by a proximate reference to mechanical measurement. There is not, so far as my inquiries have gone, anything less definitely settled among the skilful in these matters, than the point at which the calcination of the flux is completed, and the deoxydation of the mineral begins. Some deny altogether that any one point can ever satisfy both of the conditions, for they assert that the reduction always begins before the calcination is perfected; and all concur that the point, if there be one, must vary with the form and proportions of the furnace, and the chemical elements of the ore, the flux, and the fuel, and that it is, moreover, affected sensibly by atmospheric changes.

This indication is too vague therefore, and, under the varying circumstances to which it must be applied in practice, too erroneous also, to vindicate for the patented discovery the broader or generic character.

The other indication, which refers to a proportionate distance from the tunnel head, "one-third, or thereabouts," is merely specific.

The interpretation, therefore, which I am constrained to give to the part of Mr. Detmold's patent, which is involved in the present discussion, limits his claim to the formal arrangement, without an assertion of right to any dominant principle. The defendants have perhaps derived instruction from his descriptions, and may even to some extent have modelled their furnace, with its appendages, upon a theory which they suggested. But it does not appear to me that they are infringing or have infringed his patent.

The motion for injunction must be dismissed.

Messrs. Harding, Campbell, Hazlehurst, and Cadwalader, for the motion. Messrs. Sheppard, Gerhard, Meredith, Williams, and Mallery, contra.

For the Journal of the Franklin Institute.

Remarks on the Opinion of Judge Kane, in the Case of Detmold vs. Reeves.

To the Committee of Publication.

We furnish for publication in your Journal, the foregoing opinion of Judge Kane, of the Circuit Court of the United States, for the Eastern District of Pennsylvania, in the case of C. E. Detmold *vs.* D. Reeves, involving the validity of a patent issued to Mr. Detmold, as assignee of Faber du Faur, of the kingdom of Wurtemburgh. This patent claims an exclusive interest in a mode for using the waste gases of blast and other furnaces, and if its validity had been established, it involved heavy damages against the owners of blast furnaces; unusual latitude of discussion and testimony were therefore allowed to the respective counsel and parties, even in this merely preliminary stage of the case. Several weeks were occupied in the hearing. The whole merits were fully spread before the Court. The printed evidence occupies a large space, and consists of the testimony of persons selected by both parties, as most likely, by their science or practical knowledge, to cast light upon the points brought in question. Perhaps few cases are better fitted to exemplify the wide field of knowledge, and the varied investigations which Judges and members of the Bar are compelled in the course of their duties to traverse and enter, than the present. We can easily conceive that the thorough comprehension of a case like this, must have been a matter of exceeding difficulty, to even the most disciplined and the best furnished minds of the profession. We are gratified to say that the case was presented to the Court with signal ability on both sides; with an ability and industry which fairly exhausted the whole case. Having a pretty full knowledge of its main features, and believing that there were objections fatal to the claim of the complainant in matter of form, as well as upon the merits; we supposed the case would go off upon some point of informality. Defendant's counsel had urged, certainly to our satisfaction, three or four fatal obstacles to complainant's recovery. We confess to some surprise, on looking at the decision, to find it furnished other objections equally fatal to the claims of the patent—to find its validity denied upon grounds which cover every vestige of presumption in its favor. It is seldom we meet an instance of more keen perception, sounder judicial discrimination, or more successful pursuit of truth in a difficult case, than is displayed by this decision. Not only were there complicated questions of science involved, but these were complicated by the variable working of the interior of the blast furnace, and further mixed up with the new and still incomplete art of employing the waste gases, as a fuel to generate steam.

It is very evident that the Judge has succeeded in mastering the mysteries thus encountered, so far, at least, as they have been explained by men of experience or men of science; the contributions of very many of whom combined, go to make up the sum of knowledge on which this case is decided. We say this because we mean to follow it by insisting that this decision *demonstrates* the invalidity of the patent in question. It does not merely decide that the claim of the patent cannot be sustained; it *shews* that it is good for nothing. No one who will take the trouble to make a sufficient acquaintance with the facts to understand the opinion, can lose a moment in perceiving that the claim of Mr. Detmold, as it now stands, is without any legal support. It may not be without use to subjoin a short statement, in reference to the patent upon which the claim of the complainant in this case was preferred.

On the 16th April, 1842, Mr. Detmold took out a patent in the United States, as assignee of Faber du Faur, to whom two patents for the same invention had issued in Europe; one in Bavaria, and one in Wurtemburgh. Upon the allegation of a defective specification in the patent of April, 1842, it was cancelled upon the petition of Mr. Detmold, to whom an amended patent was issued, 8th Jan., 1845. The petition sets out no other defect, than that the patent should have run from the 12th of May, 1840, the date of the Bavarian patent, instead of the 12th of Nov., 1841, the date of the Wurtemburgh patent. It was urged by the counsel of defendant, upon grounds which are believed to be impregnable, that the re-issued patent of January, 1845, is void for informality, in more than one respect. Judge Kane, overlooking these objections, considers the patent of January, 1845, upon its merits. It is material, however, to a full comprehension of the case, that the reader be made acquainted with the terms of the patent of April, 1842, on which the re-issue was made, as well as those of the re-issue itself. The terms employed in the first, are those of Faber du Faur, the inventor: those used in the second belong to Mr. Detmold, the assignee. The patent of April, 1842, "*claims*" as the invention of Faber du Faur; 1. "*The employing carbonic oxide gas* "*as a fuel in combination with highly heated atmospheric air, &c.* 2, Certain "*described modes of collecting and drawing the carbonic oxide gas in a* "*pure and uninflamed state, from blast and other furnaces.*" "3, *The* "*application of the blow pipe to furnaces, substantially in the manner above* "*described, by which jets of highly heated atmospheric air are forced among* "*the gases in the furnaces, thus enabling the oxygen of the atmospheric* "*air to become thoroughly incorporated with the inflammable gas, and* "*thereby effecting its complete combustion, and, consequently, a most intense* "*temperature.*"

"The inventor disclaims the *discovery of carbonic oxide gas, or of its* *combustibility;* also, the construction of blast furnaces, &c., *except so far as they embrace the apparatus for collecting and conveying the gas, and the combination of the gas chamber, air chamber, blow pipes, and long fire-bridge.*" The exceptions thus made, are fully described in the drawings which accompany this patent, and exhibit the "*new method of using carbonic oxide as a fuel, so as to have it in a pure, uninflamed state,*" and his "*new method of employing the blow pipe in furnaces, by which continuous jets of highly heated atmospheric air* are mixed *with the gases.*"

The terms thus employed by the inventor himself, in setting forth his claims, are so clear, that there is no pretence of any infringement, now, or heretofore, in Pennsylvania.

This patent, although not infringed, was subject to a claim of priority, in favor of M. Sire, of France; but we think the claim of Sire less likely to have defeated the patent of April 1842, than the re-issue of January, 1845, to which it is fatal. The claims of the re-issued patent, are in the following terms:

"*First.* I claim the collecting and drawing off the combustible gases, chiefly consisting of *carbonic oxide gas*, from blast and other furnaces, at *one or more points below the top of the fuel in said furnace*, substantially as set forth in the above specification; for the purpose of employing said gases, instead of other fuel, for the heating of all kinds of furnaces used in the various processes of manufacturing and working iron and other metals, and for the heating of *steam boilers* or any other structure requiring a high temperature.

"*Second.* I claim the above-described mode, or any other substantially the same, of generating combustible gases from any kind of fuel in separate furnaces or chambers, and conducting the same to other furnaces or structures, that are to be heated by the combustion of said gases.

"*Third.* I claim the above described mode, or any other substantially the same, of forcing through a system of blow pipes, or in any other convenient manner, heated air in numerous small streams and under a pressure greater than that of the atmosphere, into the said combustible gases in the furnaces or structures, where the same are to be used for the purpose of producing, by the rapid and intimate mixture of the heated air with the combustible gases, their immediate and complete combustion."

The intelligent reader will have no difficulty in determining that these patents are for essentially different things; their apparent connexion lies in the description and drawings, which are the same in both. If inclined to look closely, he will find that, whilst the description and drawings correspond to the invention of Faber du Faur, they do not at all fit the invention and claims of the re-issued patent. There is ground for strong presumption, that the words of the invention and claim were altered to include the actual processes of the American iron masters, and that the same precaution was not applied to the drawings. If the claim of the re-issue is to be explained by its drawings, it is substantially the same as the patent of April, 1842, of which it took the place, and which it is admitted has not been infringed; if the re-issue is to be tested on its merits as an invention, its fate must be inevitably that which Judge Kane's opinion has assigned it—utter invalidity.

It must be matter of surprise, and should be matter of inquiry, how such an amendment as that made in the re-issue, was ever permitted at the

Patent Office. It is clearly not such as is contemplated by the act of Congress under which it was made.*

We mean not in regard to the objections which lie to the formalities of the proceeding, but in reference to the extent and import of the changes made in the terms of the patent. It can only be explained on its face, by supposing that the Officers of the Patent Office, held that the drawings would control the very loose phraseology introduced for the purpose of covering the American processes; they could not have supposed that the amendments were expressly framed to make infringements *ex post facto*, and yet that would have been the effect, if the re-issue has been ruled to be valid. We are far from wishing to deprive Faber du Faur of the credit due to him for his share in the discoveries which led to the profitable employment of the waste gases of the blast furnace. We freely accord to him the praise of having preceded his French rivals in practical processes, if, as they claim, they preceded him in the invention. It would be hard to discover at this day, to which we are most indebted, the French or the German school; our impression is, that the first knowledge of this subject came to us upon the pages of the "*Annales des Mines*," and that our attention was first turned to the French attempts. Still, if the assignee of Faber du Faur had adhered to his real invention as described in the patent of April, 1842, and if that had been violated here, it might have been very difficult to have established French precedency to the "*new method*" claimed in that patent.

We beg leave further to say that, while we are not behind any in our desire to protect the interests and reward the genius of inventors, we must insist that the interests of the public are not to be forgotten. The case before us is one in point. Upon the strength of Judge Kane's decision, we may now assume the patent of Jan., 1845, under which Mr. Detmold claims, to be invalid, yet such is the difficulty of defence, and so great the expense of resistance, the complainant has already levied a very large sum from those who preferred payment, to the trouble and cost of litigation; and if all had been equally yielding, he could have exacted several hundred thousand dollars from the manufacturers of iron, not upon any just consideration, but upon their aversion to litigation. No one who does not know, could form a conception of the trouble or expense incurred in thus defeating Mr. Detmold's application for an injunction, merely the first step in his case. And it should be well considered what this application for an injunction implies,—that the blast furnaces of Pennsylvania must cease their operations, that thousands of men, women, and children, must wait for their bread, that hundreds of

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*"*Act July* 4, 1836.—Section 13.—And be it further enacted, That whenever any patent which has heretofore been granted, shall be inoperative or invalid, by reason of a defective or insufficient description or specification, or by reason of the patentee claiming in his specification, as his own invention, more than he had, or shall have, a right to claim as new, if the error has, or shall have arisen by inadvertency, accident, or mistake, and without any fraudulent or deceptive intention, it shall be lawful for the Commissioner, upon the surrender to him, of such patent, and the payment of the further duty of fifteen dollars, to cause a new patent to be issued to the said inventor, for the same invention, for the residue of the period then unexpired, for which the original patent was granted, in accordance with the patentee's corrected description and specification."

thousands of dollars of capital must be sunk, and untold damage to property be incurred, whilst the courts are determining the validity of a patent, which may at last turn out to be wholly worthless.

THE FURNACES.

*The Royal Prussian War Steamers Nix and Salamander.**

The war steamers "Nix" and "Salamander," are two sister vessels, which have been built and equipped for the Prussian Government by Messrs. Robinsons and Russell, the eminent engineers of Millwall. These vessels are armed on a peculiar system, recently patented by John Scott Russell, Esq., F. R. S., one of the members of the firm, and offering considerable advantages over the ordinary method of arming steamers as adopted in our own and foreign navies.

It is acknowledged on all hands, that the introduction of steamers has completely nullified all our experience in naval warfare, but it is not so uniformly agreed as it should be, what is the best method of fulfilling those conditions which are necessary to future success. For a most interesting discussion of the subject, we must refer our readers to the Report of the Committee to enquire into the Practicability of Arming the Mercantile Steam Marine of this country, published in our volume for 1849. Although differing on other subjects, all admit the inadequacy of the ordinary armament of steamers. Lieut. Julius Roberts, a marine artillery officer, "would not call a steamer armed, if only with *broadside* guns and paddle-wheels—wants heavy pivot guns." J. R. Engledue, Esq., R. N., (Superintendant, P. and O. Co.) says, "since the late war the armament of every nation has advanced, and nothing but a heavy gun will do now." Capt. W. H. Henderson, R. N.: "*Large* steamers would be available against line-of-battle ships, because the latter would be taken on her weak points by the *larger guns* of the steamer, which would keep at a distance." Capt. H. D. Chads, R. N.: "We attach too much importance to speed, and forget the guns."—"An efficient armament both at the broadside and extremities are necessary."

It thus appears that a steamer must have heavy guns, and enough of them, to enable her to go into action with any chance of success. Captain Henderson lays stress upon the size of the steamer, assuming that only our large steamers can carry heavy guns. The cause of this disproportion of weight of metal to tonnage is apparent. The danger of exposing the broadside of the steamer, has caused our vessels to be armed only at the extremities, with one heavy gun at bow and stern, where, if speed is to be obtained, the lines must be fine; thus affording an inadequate support for the weight to be carried. The effect of this weight in a heavy sea is distressing to the vessel, and materially injures her seaworthy properties.

These difficulties are at once obviated by Mr. Russell's arrangement. The sponsons are enlarged, and the side of the vessel made immensely strong at that part by the iron arch shown to the left hand in the section at E, F. On these sponsons are placed the four 68-pounder guns, 1, 2, 3, and 4; the weight being thus removed from the extremities to the centre, the strongest part of the vessel, where the breadth of beam is best able to carry them. When gun 2 is trained as gun 4, their fire can be made to converge to any point from 100 yards distance, and the vessel can thus engage end-on, firing *two* guns, and offering her bow or stern only as a target for the enemy. If engaged with two vessels at once, she can as readily use all four guns, and simultaneously. When not engaged, each gun is housed in the position shown by gun 1, the weight being thus brought to the centre of the vessel, and equally distributed. A pair of 32 pounders afford additional means of attack or defence when required by the nature of the service.

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* From the London Artizan for June, 1851.

The vessels themselves are constructed both ends alike, and with a rudder at each end, so that they can go ahead in either direction without turning round. The rudders are protected by being housed, as it were, in the cutwater, and are entirely below the water-line. They are held in position when either is out of use, by a pin dropping into the rudder, and lifted by means of a screw and handle. The light draft of these boats, about 6 feet 9 inches, when fully equipped, adapts them to river service, and enables them to take refuge in shallow water when pressed by a superior force, which, if not armed with guns of equal weight, has no alternative but to decline the combat.

We had the pleasure of witnessing a most satisfactory trial of the *Nix*, on the 29th of March, when the average speed at the measured mile was 11·684 knots per hour, the engines making 32 to 34 revolutions per minute. The heavy guns were fired, and showed the accuracy of the gunnery by the shot crossing each other at 300 to 500 yards distance.

The following are the leading dimensions of the hulls, engines, and boilers:—length, extreme, 186 feet; beam, 26 feet; depth of hold, 11 feet 6 inches; 560 tons burden. A pair of oscillating engines of 160 horses nominal power; indicated ditto, 754; cylinders, 48 inches diameter × 4 feet 5 inches stroke; inside diameter of boiler tubes, $2\frac{1}{2}$ inches; consumption of fuel, $3\frac{1}{4}$ lbs. per indicated horse power per hour; capacity of bunkers, 100 tons. Weight of machinery, coal bunkers, boilers, &c., 80 tons. Frames of vessel, $3\frac{1}{2} \times 3 \times \frac{3}{8}$ inches; thickness of plates, $\frac{1}{2}$ and $\frac{3}{8}$ inch.

The hull is divided into 13 water tight compartments by 12 bulk-heads. The boilers are entirely separated from the engine-room, and the bulkheads are fitted with doors, which allow a passage from the engine-room to the stokehole, and can be set up by screws, to render them tight in case of the boiler being struck by shot. To diminish the risk of this, as far as possible, they are well defended by the coals, and the hull is lined with teak, 8 inches thick.

On Furnace Bars.*

In the sitting of the 18th of July, M. Auguste Perdonnet in the chair, M. Polonceau gave an account of a paper of M. Arson, on a furnace bar of a new shape, made of two common bars melted together so as to form only one piece, by contact at their ends as well as in the middle. The hollow between the bars is one-third inch, the thickness of the bars themselves being one-half inch; but the hollow may be brought down to one-quarter inch, for the same width of bar. He observed, that experience has shown the advantage of making the bars thin, and their intervals narrow, which allows the air to be spread more uniformly among the burning heap, and stops the small coal from falling through the bars. These bars have the evil of getting out of shape, but M. Arson's plan overcomes this. The only hindrance to the new plan of bar is in the moulding, but M. Arson has been successful.

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* From the London Architect for September, 1851.

It was observed, that on the Northern Railway they had given up cast iron bars for the fixed engines in the workshops, because they get out of shape and become very rough. These have been replaced by wrought iron bars, costing about 2*d.* a pound, being double that of cast iron, but lasting twice as long; and when of no use for bars, saleable as old iron.

One of the members supported this observation, but said the cost of the bar is 1¾*d.* a pound. The maker is furnished with ends of rails reckoned at ¾*d.* a pound; and he gives weight for weight of finished bars at 1*d.* per pound for workmanship. When he is supplied with old bars used up, he requires 125lbs. of old iron, for 100lbs. of new furnace bars, which brings the price up to 2*d.* a pound. It is found worth while to work up the old iron in this way.

It was remarked, that coal burns wrought iron more than cast, but that it was not so with coke.

A member recommended the employment of bars of which the ends are beveled on the upper edge, which prevents misshaping by unequal heating. These bars have been used with advantage in several works at Douay, being on a similar plan to locomotive bars.

Another member said he had tried the double bar of M. Arson. These bars were half an inch thick with half inch openings, and they were used in a furnace worked with coke. The combustion was better, but at the end of some time the bars were so misshapen by striking off the clinkers, that he was driven to change them and go back to the old bars.—*Proceedings of the Society of Civil Engineers, Paris.*

On Carriage Springs.[*]

At the same sitting, M. La Salle gave some account of the theory and experiments of M. Blacher, as to springs, such as suspension springs for carriages. M. Blacher assumes an elastic bar of uniform section placed on two points of support, situated at like distance from the ends of the bar. If to each end of the bar are applied two equal vertical forces, M. Blacher demonstrates that the momentum of elasticity is constant for all that portion of the bar comprised between the points of support, and which consequently on bending takes a curve exactly circular; and that the arms of the lever of the forces causing the flexure are equal to the projection of the bar—that is to say, to the distance from the points of support to the ends. It follows, that if we substitute for the points of support, the extremities of a second bar supported itself by a third, and so on in such manner as to place one upon another, a certain number of bars of equal thickness, of equal width, and having lengths decreasing so that the projecting ends shall all be equal among themselves, then these bars will bend under the influence of the first, only touching at the ends, and all taking exactly the same circular curve.

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[*] From the London Architect for September 1851.

The parts of the bars projecting from the points of support, will equally bend in arcs of a circle, if care be taken to give them the form of solids of equal resistance starting from the points of support.

This reasoning applies equally to blade springs, bound together of equal radii, and which are straightened by a load.

Mr. Blacher lays down—

First, That the flexure is proportional to the load: that is to say, that at each partial and constant addition to the load, there is a corresponding partial and constant flexure throughout the whole extent of the flexure.

Second, That the flexure is in inverse ratio to the number of springs: that is to say, that for a double load there is needed (all other things being alike) a double number of springs.

Third, That the flexure is proportional to the cube of the length developed by the spring.

Fourth, That the flexure is in inverse ratio of the width and of the cube of the springs or plates.

M. La Salle concluded with some observations of his own. He considered that for a steel spring of the first quality, it ought not to be subjected to a tension greater than would cause an extension of substance of $\frac{1}{300}$ in length. At least, this is his opinion, until further experience determines within what limits elasticity can be maintained. He likewise observed, that the new system of springs, called "compensation springs," has been lately tried in France; these springs being composed of a small number of plates which, in proportion as they bend, spread out on a rigid bar. These springs, which at first sight appear lighter than common springs, are under bad conditions of solidity and durability, because the steel is worked to its utmost limits, and most frequently to a lengthening of $\frac{1}{200}$, so soon as the middle begins to spread out under the influence of a load. If they wished they could work steel as much in common springs, and could considerably reduce their weight, which would then come out much lower than compensation springs. In his opinion, the principle of compensation springs was not rational. He found in them a radical vice, inasmuch as their sensibility diminished just as the load they bear increases—that is to say, that they lose their flexibility precisely at the moment when it should be as great as possible.

M. Polonceau, who has made some experiments lately on the two systems, explained that the new springs spreading out on a rectilinear bar, and shortening by all the length applied on this bar, offer a lever-arm shorter and shorter as they go on bending. At first sight, it had seemed to him, as to everybody else, that under a given load these springs ought to act much in the same way as a common spring, shorter by the whole quantity in contact on the rigid bar: experience has, however, proved that compensation springs exhibit extraordinary elasticity. For the present he had no wish to prejudge the question, as he was engaged in ascertaining the working of the new springs; but he would give an account of his experiments to the society when completed.

M. La Salle is of opinion that the characteristic which essentially distinguishes the two systems is flexibility. In common springs the flexibility is proportionate to the load; in compensation springs, on the other hand, the flexibility decreases rapidly just as the lever-arms diminish under the influence of an increase of load, since the flexure is in inverse ratio to the cube of the length. In the experiments made on the Orleans Railway, they endeavored to load, first, each of the springs under experiment with a steady load of 5000 lbs., then with an additional load of 2000 lbs.; which, being taken off all at once at a given time, caused a reaction of the spring, which was shown by more numerous shakings or oscillations in the compensation spring than in the common spring. Hence it was drawn that the first was more elastic; but it must be said that the common spring, being composed of a greater number of plates, has to overcome greater friction, and that, consequently, its oscillations will stop sooner. To his mind the friction of the plates is of advantage when not carried too far, since it exactly prevents the oscillations from being kept up. A spring should not be absolutely elastic. The principal condition is, that it should be flexible; and as to friction, it absorbs beneficially a part of the force developed by the shock.

A member is not of the same mind as to friction, for if M. La Salle is right, the old springs are best of all; and that cannot be. Springs ought to have a great flexibility; they ought to bend much when heavily laden; and friction must certainly lessen its flexibility.

M. La Salle answered, that if friction is useful within certain bounds, it need not be so excessive as in the old springs. To be easy, a spring ought to be flexible, and produce oscillations of given fullness; and it was not, therefore, to be held out that the friction would be considerable enough to destroy the flexibility of the spring. For ease, it is desirable to make the springs as long as possible, because these being capable of being composed of a smaller number of plates, afford less surface for rubbing. He held, too, there are cases wherein too much elasticity is hurtful. For carriers and diligences he had made springs composed of five or six plates of 0·4 inch thickness. These springs were very easy under heavy loads, but they were less so when the carriages were empty; and in both cases caused them great swaying. Since then, he had put, instead of these springs, other springs made up of a greater number of thinner plates, which afforded much the same flexibility and the same weight. These latter, which showed much more friction, were preferred.—*Proc. of Soc. Civ. Eng., Paris.*

Water Pipes.[*]

Messrs. Neilson of the Hyde-park foundry, are at present under contract to supply about 30 miles of cast iron pipes to the town of Liverpool, for bringing the water from the Pike. They are 3 ft. 10 in. in diameter, the iron of which they are made being $1\frac{3}{8}$ inches thick. Each length measures fully 12 feet; and in every one of these there are nearly 4 tons of iron. Upwards of 1200 have already been delivered and shipped for Liverpool. The average number of lengths turned out does not exceed five per day, which involves a consumption of nearly 20 tons of iron. Every pipe before leaving the foundry is subjected to a severe test by hydraulic pressure. The moulds, which stand about 13 feet high, are sunk into the ground, bringing the top of the cylinder nearly on a level with the surface. The liquid metal weighing, as already stated, about 4 tons, is brought by means of a steam crane from the melting furnace, and poured into the mould.

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[*] From the London Architect for August, 1851.

On the Conduction of Electricity through Water. *By* MR. F. C. BAKEWELL.*

This paper gave the results of some experiments on the conduction of electricity by water, made with a view to prove that an electric current may be transmitted for a considerable distance through unprotected wires immersed in water. The experiments were conducted on Saturday, June 28th, in one of the Hampstead ponds. A thin copper wire (No. 20), 320 feet long, was stretched across the pond, and two copper plates, 10 inches square, to which wires were soldered, were immersed to serve as conducting plates for the return current. A Smee's battery of two pair of plates was used; and when the connexion was made with a galvanometer on the opposite bank, a steady deflexion of 30° was maintained, and a strong blue mark was produced by a steel electrode on paper moistened with a solution of prussiate of potass in diluted muriatic acid. In this experiment the conducting plates were placed close to the wire and on opposite sides of it, so that the return current passed diagonally across the exposed wire. The water in this case appeared to act as a conductor and as a non-conductor at the same time, in proportion to the surfaces exposed to its influence. In the next experiment the wire was doubled, and a current of electricity from the same battery was transmitted through the wires, both being immersed in the water. In this case the deflexion of the needle was more powerful, and it continued steady at 45°. From these experiments, which Mr. Bakewell stated were a confirmation of those undertaken by Mr. Bain and Lieut. Wright with a different object in 1841, he inferred that the exposure of a large surface, as the electric telegraph wires from post to post, presented greater opportunity for the dispersion of electricity in moist atmospheres than the points of connexion with the posts.

FRANKLIN INSTITUTE.

Proceedings of the Stated Monthly Meeting, September 18, 1851.

Francis Grice, Esq., President pro tem., in the chair.

Isaac B. Garrigues, Recording Secretary.

The minutes of the last meeting were read and approved.

Letters were read from The Royal Geographical Society, London; and J. Erricsson, Esq., New York.

Donations were received from The Royal Institution of Great Britain; The Royal Geographical Society, and the Royal Astronomical Society,

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* From the London Architect for August, 1851.

London; Thomas Ewbank, Esq., Commissioner of Patents, Washington City, D. C.; Simeon Borden, Esq., Fall River, Mass.; J. Erricsson, Esq., New York, and Robert Smith, Esq., George W. Smith, Esq., and Prof. John F. Frazer, Philadelphia.

The Periodicals received in exchange for the Journal of the Institute were laid on the table.

The Treasurer's statement of the receipts and payments for the month of August was read.

The Board of Managers and the Standing Committees reported their minutes.

New candidates for membership in the Institute (7) were proposed, and the candidates (6) proposed at the last meeting were duly elected.

Dr. Rand, Chairman of the Committee on Meetings, presented several specimens of iron coated with copper, a new article sent to the Institute by Mr. Ebenezer G. Pomeroy, of Cincinnati, Ohio, and for which he has taken out a patent. His process is as follows:—

Immerse the iron in dilute sulphuric acid, for the purpose of cleansing the surface of the article which is to be coated; and thus cleansed, submit the iron to a brisk heat to dry it; when dry, immerse the article in a mixture of clay and water, and again dry it so as to leave a thin coating of the clay on its surface; it is then to be immersed in a bath of melted copper, and the length of time requisite for the iron and copper to form a union, will depend on the thickness of the article under operation. The object of the clay is to protect the copper from oxidation during the process of alloying or coating, and to reduce it to the required thickness it is passed between rollers. The result of this annealing process will be a smooth surface, fully equal to the brightness of pure copper.

The specimens presented to the Institute had all the appearance of pure sheet copper, and are considered by the patentee applicable to the same purposes.

Dr. Rand also exhibited specimens of cotton fibre which had been immersed in a cold solution of caustic soda, after the method of Mr. Mercer, by which the fibre had undergone condensation. The amount of this change was stated to be one-fifth to one-third of the original volume of cotton employed, increasing its fineness by a chemical union with the soda. By this process the strength of the fibre was also stated to be increased in the proportion of 20 to 13; and certain colors are much brightened. (Vide Report of the British Association in *London Athenеum, for July,—Journal of the Franklin Institute, present Vol. p.* 204.) This subject will again be brought before the Institute.

Mr. G. W. Smith brought before the meeting an interesting specimen of flax cotton, made after the process of C. Claussin, and gave an account of his method.

The next subject of interest was an exhibition of the operation of one of Phillips' Patent Fire Annihilators, which was kindly loaned for the occasion by Mr. Sandford, of Adams' Express of this city, and put in operation by Dr. Hall, one of the patentees in this country. The portable apparatus is sixteen inches in height by eight inches in diameter, and consists of a machine composed of two thin iron cylindrical cases within one another, the central case containing a brick composed of charcoal, sulphate of lime, and nitrate of potassa, and in the centre of this brick a bottle containing a mixture of chlorate of potassa, in which is contained a portion of sulphuric acid. This deflagrating compound fires the inside by a pin being pressed down from the top so as to break the vial and ignite the brick, which creates a great amount of heat, sufficient to generate steam in the bottom of one of these cylinders, which unites with the gases evolved so as to produce a large jet of white vapor, without any suffocating odor; it was exhibited in a room in which there were not less than fifty persons, without producing cough or any disagreeable impression. The apparatus was merely exhibited in order to show its construction and mode of operation. A trial to test its practical merits was announced to take place in a few days.

COMMITTEE ON SCIENCE AND THE ARTS.

Report on Wm. C. Grimes' Steam and Water Indicator.

The Committee on Science and the Arts, constituted by the Franklin Institute of the State of Pennsylvania for the Promotion of the Mechanic Arts, to whom was referred for examination, a "Steam and Water Indicator," invented by Wm. C. Grimes, of Philadelphia, Penna.—REPORT :—

That the instrument of Mr. Grimes, which is intended to indicate continually the height of the water, and pressure of the steam in a boiler, at any required place at whatever distance from the boiler, consists in two metallic tubes which are inserted, the one into the steam space, the other into the lower part of the water space of the boiler, and extend from the boiler to the place at which the indications are required to be made, where the ends of the tubes are brought side by side and connected together by a bent glass tube, one end of which enters each of the metallic tubes. In the simplest form, (which is described for the purpose of explaining most simply the theory of the apparatus,) the tube connected with the steam space (which may be called the upper tube) enters the boiler at the water line and runs for some distance horizontally, or a little inclined downwards, when it again bends downwards for some inches, and then runs in any convenient direction to the glass tube. The object of this arrangement is to allow the steam to condense in this part of the tube, and to keep the water which fills it always at the proper water level of the boiler. Each of the tubes is provided with a stop-cock near the boiler, and on each of them immediately below the glass tube there is a small hole, (called by Mr. Grimes the air-hole,) which may be closed by a screw. In order to put the apparatus in working order, the boiler is filled to above the water line, the stop-cocks of the tubes being closed, and a small pressure of steam raised; the stop-cock of the upper tube being then opened a little, the water will enter the tube, and expelling the air before it through the air-hole, will finally begin to run through this hole; the stop-cock of the upper tube is then closed and the plug of the air-hole screwed in. The lower tube is then filled with water in a similar manner. The apparatus then contains water in the metallic tubes, and air in the glass tube or gauge. If now the stop-cocks on the tubes be opened, and the pressure of the steam increased, the air in the gauge will be compressed proportionably, and the water will rise to an equal height in each branch of the tube; in this way the gauge may be graduated by direct experiment. But the fall of the water level in the boiler will cause the level to fall also in that branch of the gauge which communicates with the lower tube, (that is, the tube opening near the bottom of the water space of the boiler,) and this will cause the water to rise in the opposite branch of the gauge in consequence of the necessity of the column of air retaining its bulk. While, therefore, the pressure of steam in the boiler is indicated by the mean height of the columns in the gauge, the fall of the water below its adjusted level will be indicated by the difference of the height of these two columns, provided the level of the water in the boiler end of the upper tube be maintained constant.

In practice this construction is modified by the introduction of another vertical tube connecting the end of the upper and lower tubes near the boiler. The upper tube is then inserted into the steam space of the boiler, and it leaves the connecting tube at the proper water level, when it runs as before described; in this way there will be left but a small portion of the upper tube to be filled by the condensed steam. The lower tube is also provided with a blow-off cock between the boiler and the stop-cock before described, to prevent this tube from being choked by sediment. The level of the water in the gauge is indicated by a floating glass tube, colored and graduated in the inside, and closed in the leg communicating with the upper tube, while a glass ball floats on the surface in the other leg. The difference in the levels of the water columns is then indicated by the position of this ball on the graduated scale of the glass tube in the other leg.

The indicator thus described has been for some time in operation in several steam boilers in our city—especially in the boiler at the office of the Public Ledger, where the gauge is brought up into the office, and may be seen constantly in action. And so far as the committee can learn, they appear to have given satisfaction.

The committee regard the invention of Mr. Grimes as a very ingenious one, and as fulfilling a very desirable purpose, that of indicating the steam pressure and water level of a boiler, in the office of the manager of the establishment. They think that it will require an experience of some time to ascertain satisfactorily that the water level of the boiler and of the tube connected with the steam space can be kept constant by the condensation of the steam, but they see no other practical objection to the instrument, which appears so far to have given satisfaction in practice. And as they believe that it will be found to be useful in engineering, and so far as they know, new, they recommend that Mr. Grimes receive the Scott's Legacy Medal for his invention.

By order of the Committee.

William Hamilton, *Actuary.*

Philadelphia, July 12, 1851.

Description by the Inventor, of the Gauge for showing the Height of Water, &c., referred to in the foregoing report.

The figures represent two forms of the instrument, together with an illustration of the principle upon which they act.

The same letters refer to like parts.

A, is the boiler; *a*, reservoir of water; B B, metallic tubes; C C, legs to the glass syphon; D D, the stop-cocks; E E, are screws closing

Fig. 1.

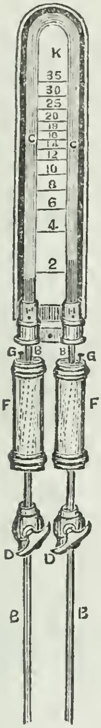


Fig. 3.

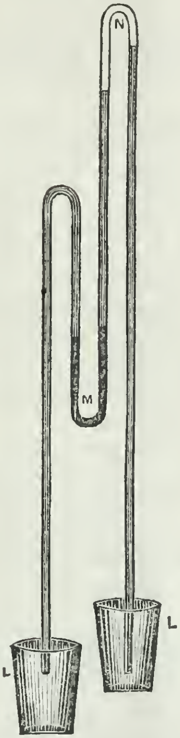
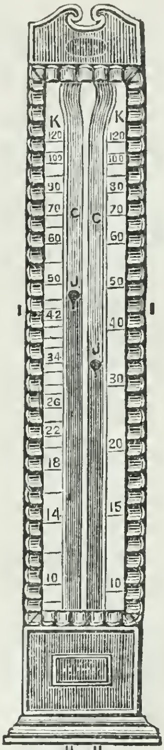
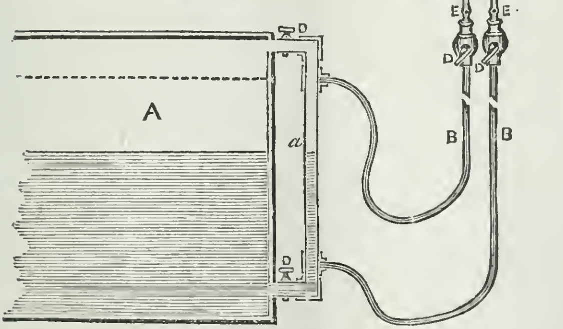


Fig. 2.





apertures in the tubes, which are to allow the air to escape as the tubes fill with water or other fluid. F F, in fig. 1, are reservoirs for containing quicksilver, or other dense fluid. The tubes B B, both from above and below, extending into the reservoirs nearly to the opposite end of the same; G G, small screws closing apertures in the upper ends of the reservoirs, through which they are filled, and through which the air escapes as the tubes below fill with water; H H, are screws closing apertures in the tubes, B B, between the reservoirs, and the glass through which all the air is allowed to escape up to that point. I I, in fig. 2, is a wooden case inclosing the glass of the syphon; J J, high colored glass floats to render more visible the tops of the columns of water that rise in the syphon. An elastic fluid fills the space above the floats. K K, graduated scale plates.

Fig. 3, represents a glass syphon with the ends of the legs in the cups, L L, of water, for the purpose of illustrating the principle of the instrument. If the syphon is nearly filled with water, with a small portion of air above, as represented at N, and one of the cups be raised or lowered, a corresponding movement will take place at the tops of the columns of water. Or if a quantity of some fluid more dense than water, (quicksilver for instance,) is placed in the bend at M, and the rest of the syphon filled with water, then the movement of the cups up or down, will cause a corresponding movement of the fluids in the syphon, but in a degree diminished in proportion to the density of the fluid in the bend.

This instrument was also referred to in the proceedings of the Franklin Institute, and published in Vol. xx., p. 287, of the Journal of the Institute.

BIBLIOGRAPHICAL NOTICE.

Elements of Analytical Geometry. By Albert E. Church, A. M., *Prof. Mathematics, U. S. Military Academy.* New York: George P. Putnam, 1851, 8vo.

This is an excellent treatise founded on the admirable and classical work of Biot, but with such alterations in the arrangement and demonstrations of the proportions, as appeared fitted to render it more methodical and convenient for use. From the hasty examination which we have made of it, it will, perhaps, be scarcely safe to express an opinion upon the result of these changes, but we cannot forbear saying that they do appear to us, calculated to produce the advantages sought.

The science of analytical geometry is one which ought to be better known to, and more cultivated by, our mechanics, as it gives them not only clearer ideas of any problem and of its connexion with others, but, moreover, habituates them to more rigid examination of principles and stricter modes of thought. As a means of detecting error in plausible propositions, and of determining the theoretic relation between power and effect, it has no equal. We should like to see it more generally taught in our schools for those who are destined to mechanical employment, and can safely recommend the present work as a text book.

F.

JOURNAL

OF

THE FRANKLIN INSTITUTE

OF THE STATE OF PENNSYLVANIA

FOR THE

PROMOTION OF THE MECHANIC ARTS.

NOVEMBER, 1851.

CIVIL ENGINEERING.

On the Asphalted Macadamised Roads lately laid down in Paris. Compiled from the 'Annales des Ponts et Chaussées, 1850.' *By* M. De Coulaine, *Engineer of the 'Ponts et Chaussées.'*[*]

Continued from page 228.

Chapter VII.—Maintenance and Repair of Asphalted Roadways.

The powers of resistance and the durability of this kind of roadway being now beyond question, other points not less important remain to be discussed.

The first which calls for serious examination is the mode of maintenance. If, in fact, the mode of executing a roadway has an importance whose gravity is beyond discussion, the methods employed for its maintenance have a much greater influence upon its goodness and the services it is able to perform. A road, let it be ever so well constructed, if it be not properly maintained, must soon become useless; whilst, on the contrary, proper methods of repair may correct, or at least attenuate, any original defect.

The maintenance of any roadway has two objects in view: one being to repair and efface any alteration or deformation produced by the traffic; the other being to replace progressively, or at slight intervals, the waste produced by the gradual wearing down of the materials.

The earliest system employed by M. de Coulaine consisted, 1st, as far as partial repairs were concerned, by "picking" it all over in the first place, and then laying about $\frac{3}{4}$ inch of hot mastic over the whole surface.

2d, As far as the general wearing away of the roadway was concerned, by well clearing its surface, and covering it with a layer of mastic of the requisite thickness, applied hot.

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[*] From the London Architect for September, 1851.

Very serious inconveniences are attached to both of these methods. For they require that the whole assemblage of cauldrons and experienced workmen should be sent for on every occasion; and they are wanting in the first condition of a theoretically perfect system of maintenance, inasmuch as they are not of a nature to enable the defects of a roadway to be repaired without proceeding to a reconstruction of the whole structure.

The process about to be described, obviates these inconveniences. After having perfectly cleaned the place to be operated upon, a layer of liquid bitumen (formed of 3 parts of oil of resin and 1 of Bastenne bitumen) is to be laid on with a brush. Over this layer, pounded asphalte is to be moved backwards and forwards with a broom, until the bitumen can no longer take it up; then some sand is to be sifted over the whole. When the carriage wheels have passed over the surface, the sand which has not combined with the asphalte should be removed with a broom. After a few days a layer of mastic, from $\frac{3}{4}$ to $1\frac{1}{4}$ inch in thickness, and of a great degree of resistance, becomes formed over, and intimately connected with, the subjacent bitumen, by the action of the traffic and the natural affinity of the different materials employed.

The bituminous oil above described must be prepared in the shop previously to the application. The bitumen is melted in the cauldron first, and the oil of resin indicated is subsequently added; as soon as the combination is perfect, the oil is removed from the fire in order to avoid useless evaporation.

To ensure the rapid setting of the bituminous mastic, it is necessary, 1st, that the layer of oil be very thin, and spread in about the proportion of 0·07 lb. avoirdupois per foot superficial; the quantity of asphalte this will take up would amount to about 0·21 lb. per foot superficial. 2d, That the quantity of sand be not too considerable; it would be sufficient, to ensure this, simply to observe the precaution indicated, and to remove the useless sand as soon as the traffic has passed over it. 3d, That the operation be carried on in fine weather, that is to say, between May and September: the sun's heat appears to be indispensable to ensure success.

It is also preferable to use asphalte which has been pulverised cold, because it contains more bituminous matters than that which has been pulverised by the aid of heat. When the surface of the roadway to be repaired is very rugged, it will be necessary to substitute asphalte in small fragments for the asphalte in powder, and the dimensions of these fragments should be in proportion to the ruggedness.

This mode of repair was first tried at the end of the summer of 1845. Subsequently it has been the only one used, to the exclusion of all others, and has invariably produced the best results, and it may be applied either to partial or general repairs.

Portions of roadways in a very defective state, either from the nature of the material, or on account of the advanced season of the year when they were executed, or, perhaps, on account of their foundation, have been repaired by this method with the most perfect success. The bituminous oil appears to have entered these parts, to have rendered them more elastic, and to have, in a manner, re-soldered the particles at a certain depth. It has, at the same time, by its combination with the asphalte and sand, covered them with a layer of mastic, which has re-established the solidity of the structure, and restored its even surface; thus the whole process may be said to fulfil the conditions stated to be those requisite to constitute a perfect system of maintenance.

Moreover, this system, which is so easy in its application, only costs about one-half of the one in which the bituminous mastic is applied hot.

CHAPTER VIII.—NEW PROCESS OF CONSTRUCTING ROADWAYS IN BITUMEN WITHOUT CAULDRONS, AND WITH COLD MASTIC.—APPLICATION TO THE PLANKING OF WOODEN BRIDGES.

The experimental essays for the maintenance above described have had another advantageous result; they naturally led to the endeavor to lay down a roadway in a similar manner. In this new system, as in that lastly described for the maintenance, the asphalte and the aggregating substances are laid cold. It may be described as follows:—

Seyssel stone is comminuted into pieces of the size usually employed for the construction or repair of roads. The fragments which are too small, are separated by passing the stones through a sieve, whose openings are ¾ inch wide by two inches long: the larger fragments thus separated are covered with liquid coal tar and shaken in the sieve, so as to ensure their being entirely covered by that liquid. This operation is intended to facilitate the aggregation of the calcareous asphalte. The macadam, which serves as a foundation, is then covered with a layer of these materials from 1¾ to 2 inches thick; the layer should be well rammed, with rammers weighing about 45 lbs.

When the fragments of asphalte are thoroughly bound together, the interstices are to be filled in with a bituminous sand previously prepared, as follows:—

Seyssel Asphalte, in powder, ...	202·5 lbs.
Ordinary Sand, ...	135·0
Oil of Resin, ...	16·9
Bastenne Bitumen, ...	5·7

These materials are combined in the usual manner. They are then poured out, and divided by a toothed rake into small fragments, which are exposed to gentle heat with some asphalte in powder to prevent their re-combination. At the time of use they are to be separated from the asphalte in excess by means of a sieve, and sprinkled with a proportion of about $\frac{1}{100}$ to $\frac{2}{100}$ of the oil of resin.

The sand thus prepared is to be spread over the roadway, and forced by a scraper into all the spaces left by the asphalte stones, without, however, covering the latter, which are to be left apparent; the mastic is then to be further consolidated by being beaten with a flat tool, so as to fix the sand in the interstices. The quantity thus introduced may be estimated at from 2 lbs. to 2¼ lbs. per foot superficial. The ramming is then resumed until the layer of macadam is sufficiently compressed. To prevent the mastic or the coal-tar from sticking to the rammers, they should, from time to time, be dipped in water; or this inconvenience may be obviated by the use of a little asphalte in powder. But this part of the operation is far more satisfactorily performed if a cylinder be used. Whatever method be employed, the traffic of a few days will give all the consolidation required.

If the surface of the roadway be closely examined, a great number of bruised or broken fragments of the asphalte in powder may be observed, owing to the fact that the asphaltic limestone is not sufficiently rich in bituminous matters. At the expiration of a certain period these stones become partially covered by the sand which protects them, and combine with the dust and splinters of the asphalte. However, to ensure a prompter and more complete aggregation, it is advisable to moisten the surface of the macadam with a layer of bituminous oil, and to cover it with asphalte and sand, by means of a sieve, as has been described for repairs.

It is of the greatest importance that the roadway which serves as a foundation for the asphalte should be of a very great degree of hardness; without this, the consolidation of the bituminous mastic would take place with difficulty, the oleaginous matters would become intermingled with the stones, and would communicate to the roadway a degree of softness which it would never lose.

This system of making the roads cold, like the system of repairing them in a similar manner which led to it, and of which it may be considered the natural consequence, has many very important advantages. Firstly, it is so simple and easy that it can be performed by workmen totally unused to the class of material, the bitumen, which may be said to characterize the process; and the success thus becomes, to a great extent, independent of the care or skill of the workmen. It requires no heat, nor any of the cumbrous machinery of the cauldrons, and obviates the dangers attending the excess or falling short of the degree of heat.

Secondly, the application can take place at any season of the year, provided the foundation be solid, an advantage which is far from being possessed by the pavements requiring heat for their application. Some trials made in the winter 1848-49, have indeed been as successful as those made in summer. As the aggregation is produced by compression and by the action of the traffic itself, this system appears to present the greatest guarantees of solidity.

Lastly, the layer of asphalte thus applied, offers in its composition and properties, the most striking analogy with ordinary macadamised roads. It forms, in fact, a species of macadam, in which the asphalte performs the functions of the broken stones, and the malleable mastic those of the sand and of the detritus. By means of the portions of asphalte which appear on the surface occasionally, a resistance is offered to the wheels of the carriages; whilst a foot-hold is given to the horses by the soft mastic which forms the remainder of the combination. This kind of roadway, therefore, unites two advantages, apparently opposed to one another: it presents a firmer surface than the pavings executed warm can do to the rolling traffic; and also, it obviates in the most complete manner, all danger arising from slipperiness.

It follows, from the composition above indicated, that the changes of the atmosphere affects this kind of roadway to a much less extent than they do any others of a similar nature. Indeed, of the four elements of which the bituminous mastics are composed, the tar (whether natural or the result of distillation) is the only one liable to vary in its consistence; the limestone and the sand remain always in the solid state, and the oil preserves its fluidity under the greatest cold. The greatest degree of uniformity of character will then be attained by maintaining the tar in the lowest possible proportions.

In the asphaltic limestone, the solid element prevails to such an extent that it ceases to be fusible; in the malleable mastic, on the contrary, the oil is in excess. It is, from this, easily conceivable that the two principles in question should be but little subject to variations of temperature, and that the kind of macadam produced by their combination should neither soften in an extraordinary manner during the summer, nor cease to afford foot-hold to horses in winter.

It also follows, from the presence of the asphalte, that the carriages which may stand upon the macadam do not leave very strong marks, and that the roadway is not exposed to the same deformations from this cause, which can be observed in those where the hot mastic is used.

The facility with which this sort of roadway (whose cohesion is but feeble, and which contains hardly any other elements than the asphalte and the bitumen) can be opened, and with which it can also be reinstated, allow the repairs of gas or water-pipes, of sewers, or of any other description of under-ground works, to be carried on without difficulty. In such cases, the only precaution to be observed is, to ensure the consolidation of the foundation before the bituminous mastic is employed. The indications of any rupture in water pipes are even remarkably rapid in displaying themselves, and very easily detected.

The experiments connected with the new system of forming these roadways with a cold mastic were executed in the month of June, 1848. At first they were executed on a small scale, but in the spring of 1849 greater extension was given to them, and the results have been so far satisfactory, that the whole, or nearly the whole, of the Boulevards have been paved in this manner. But M. de Coulaine still appears to prefer the formation of the covering of vaults or arches by the use of hot mastic.

Application to the Planking of Wooden Bridges.—On wooden bridges the use of bituminous matters laid cold is, however, indispensable.

As wood contracts or expands, with the alterations of the temperature, to a great extent, the mastic applied hot, on account of its adherence to the surface of the wood, must participate in its movements, and must, therefore, crack. In the pavings usually executed for foot-passengers only, this danger is obviated by the interposition of a rather open cloth, or by that of a light layer of sand. But for a carriage road this precaution would not be sufficient, because, if two contiguous planks should happen to warp in different manners, an open space might be formed over one of them, and the traffic passing over it would necessarily cause the mastic to be broken; the successive movements of the planking under the passage of carriages would produce the same result. It is possible that, by observing the same precautions in laying the planking which would be observed in laying a floor, this danger might be avoided; but the success of this process, besides being in itself expensive, is doubtful. With the bitumen applied hot, it would then appear necessary to lay the roadway on a layer of broken stone at least 4 inches thick, thus neutralising entirely any danger from the action of the wood, but at the same time presenting the serious inconvenience of uselessly loading the bridge.

With the system of applying the bituminous mastic cold, the interposition of this layer ceases to be necessary; admitting, indeed, that the dilatation or contraction of the wood, by communicating itself to the mastic, might give rise to some cracks, they would soon disappear under the action of the traffic, which, in fact, produced the first aggregation. By this means the planking of bridges becomes protected from the action both of traffic and of weather; and one of the most important difficulties in the execution of such works, or rather in their maintenance, becomes satisfactorily solved.

When the passage over a bridge is not very frequent, it may possibly be sufficient to cover the planking with a few coats of liquid mastic applied with a brush, according to the system already indicated for the maintenance. The fissures likely to take place at the joints of the planks will be but of little importance; and in this manner a very light roadway may be obtained particularly suited to suspension bridges.

Other Methods of using the Mastic Cold.—One of these only differs from the method above described insomuch as the single layer of asphaltic stone is replaced by two layers of equal thickness,—the first consisting of silicious stones covered by a bituminous gangue, and the second of asphaltic fragments prepared as has been already described.

The stones destined for the bottom layer should be separated from too minute fragments by means of a sieve or screen, whose wires should be $\frac{3}{4}$ inch apart; or from too large fragments by the use of another screen, whose dimensions should be $\frac{1}{2}$ inch less than the thickness to be given to the roadway. Moreover, they must be perfectly dry and clean.

The gangue with which they are to be covered may be applied in several manners. The most simple is, to dip them in coal tar, to let them dry thoroughly, agitating them occasionally on the sieve used to dip them, to throw them into a mixture of two parts of asphalte, pulverised cold, to one of sand, covering them entirely with it, and stirring the whole well together with a spade. The stones are to be left for some time in the mixture, to allow the coal tar to take up as much of it as possible. A species of bituminous coating, similar to the one applied by the brush for the purpose of repairs, is thus formed over each stone.

The materials prepared in this manner are used first; after covering them with the broken asphaltic stone, the aggregation of the roadway is effected by the rammer, and the addition of the mastic, as before.

In another essay, the bituminous macadam was entirely composed of silicious stones, covered by a gangue much thicker, applied by dipping the stones into a cauldron of hot mastic, formed of the following materials:—

Bastenne Bitumen, ...	20 lb.
Oil of Resin, ...	4½
Asphalte of Seyssel, ...	135
Sand, ...	90

At the end of about a quarter of an hour the stones are withdrawn from the cauldron, and placed on a sieve for a short time, so that the bituminous matter remains in excess; they are then thrown into and stirred up with the asphalte in powder: they are afterwards to be separated from the asphalte, and the fragments of the mastic which have not adhered to the stone. These fragments themselves are also to be removed from the asphalte, and laid aside.

A day or two before these stones are to be used, coal tar is to be poured over them, in proportion of about 1 in 100 of their weight; they are to be well turned over with a rake, so as to spread the coal tar equally over their surface. The fragments of mastic are also to be covered with coal tar.

The stones are to be used in the usual way. After they have been rammed, or pressed down with a roller, their interstices are to be filled in with fragments of mastic, already mentioned; the roadway is again compressed, and during a certain time again given up to public traffic.

When it is perfectly consolidated, it should be perfectly cleaned from dust or mud, and the cavities upon its surface filled in with a bituminous sand, prepared cold, and containing 9 parts of asphalte in powder, to 6 of sand, and 1½ liquid bitumen with a base of oil of resin; this sand being fixed in the said cavities by means of a spade. Lastly, after the excess of sand is cleared away by a broom, the roadway is to be covered with a layer of asphalte applied with a brush as before described.

The stones should be passed through the sieves mentioned in the description of the last essay; it is also advisable to dry and warm them round the cauldrons, before putting them in. The principal condition in the selection of the stones should be rather that they resist crushing; for there are many stones sufficiently hard to wear away iron, which are easily splintered by smart shocks, or comminuted by heavy weights. Such stones as are the most difficult to break are the best; and they should, moreover, be very angular, in order that the mastic may adhere to them readily. The hard sandstones answered best.

The mastic with which these stones are to be covered ought to be submitted to the essay above mentioned, and the impression should be about ½ inch deep at the utmost. When it becomes too thick for the stones to be easily stirred about in it, the addition of a little pure oil of resin will restore its fluidity.

The quantity of mastic which sticks to the stones in this operation amounts to about two-thirds of their weight; the substances added to facilitate and complete the aggregation of the roadway form on the average one-tenth of the total weight of the materials entering into its composition. It follows that 100 parts of the roadway must contain nearly the following proportion of the several ingredients, viz:—

Silicious stones, ...	54 parts.
Mastic, applied hot, ...	36
Ditto, cold, ...	10
	100

The materials especially employed to facilitate the aggregation are then the $\frac{46}{100}$ of the total weight; that is to say, that they nearly correspond with the spaces which are left between the silicious matters. At the end of a certain time the mastic and the gangue, by a gradual deformation due to the pressure of the traffic, fill all the spaces; the silicious stones then touching one another, the aggregation is complete, and wheels can no longer penetrate. The gangue preserves the stones from the action of the wheels, and to a great extent prevents their communition.

The two last methods indicated give rise to a considerable economy. Even should this end be attained at the expense of a certain degree of solidity—which is by no means admitted—there can exist no reason to doubt but that the facility of repairing with cold materials, would counterbalance any inconvenience which might arise. The last method, which is a combination of the others, appears to be the most satisfactory solution of the difficulties attached to the use of the bituminous macadam.

In another experiment, the asphaltic limestone dipped in coal tar, was employed without any mastic. The aggregation took effect with a certain degree of ease, but in the manner in which it usually takes effect in roads composed of calcareous materials; that is to say, that the fragments of the asphalte were broken, and the small particles resulting thencefrom filled up the interstices. The asphaltic limestone, it is true, under the action of the traffic, had become compressed and flattened out, owing to the bituminous elements it contained. But these materials, on account of their small proportion, could not prevent the surface of the macadam from becoming pulverulent, from falling to pieces, or yielding to the same kind of causes of decay which destroy ordinary roadways. Under such circumstances a road thus constructed could not have lasted under an active traffic, or at least the rate at which it would have worn away would very soon have led to its final destruction. This was proved by the fact that, after the road had been swept, a fresh layer of asphaltic dust was formed in a few days, and so on consecutively.

The cause of this is that the asphalte is not sufficiently rich in bituminous matters; to remedy this defect all that was required was to supply the deficiency by introducing, into the macadam, the quantity of bitumen required, which seems to be successfully effected by the use of the cold materials. When the asphaltic stones had become sufficiently aggregated by the action of the traffic, M. de Coulaine, on some occasions, had the surface swept so as to remove all the particles of the asphalte in powder; it was then painted over with oil, and the latter covered with asphalte and sand, as has been previously described. After a few days' wear the roadway presented a perfectly aggregated surface, and has constantly maintained that character.

It is to be observed that the elastic mastic should protect the stones throughout the whole thickness of the road, and that it serves to render the aggregation much more prompt and complete. There is also another very important advantage connected with it, viz: that it prevents horses from slipping, and thus obviates the most serious inconvenience hitherto reproached to bituminous roads.

CHAPTER IX.—OF THE COST OF MAKING AND MAINTAINING ROADWAYS OF BITUMEN.

We have above described three leading systems for making bituminous roadways—namely, 1. When the materials are used hot. 2. When they are used cold, fragments of asphalte and soft mastic being employed. 3. The same system, excepting that the asphaltic stones are replaced by silicious stones, enveloped in a bituminous gangue.

The prime cost of each of the systems will be given, according to the rate of wages and the price of materials paid in Paris.

1. *Mastic, &c., applied Hot.*—When six cauldrons were employed at a time, the men required to work them consist of

1 Foreman, at per day, ...	4·00 fr.
3 Firemen, or stokers, per day each, 2 fr.. . .	6·00
1 Carrier, at per day, ...	2·00
1 Beater, or layer, at per day, . . .	2·00
3 Laborers to pound the asphalte, 2 fr. per day,	6·00
Total,	20·00

Such a gang of men can lay about 22 cauldrons full of the mastic per day; and as each cauldron holds 0·07 metre cube of mastic, they can lay about 1·54 metre cube; or the cost per metre superficial, and per centimetre thick, for labor only, is about, say,

Labor per metre superficial, ...		0·13 fr.
Materials—		
Each cauldron contains:		
90 kilogrammes of asphalte, at 0·10 fr. . .	9·00 fr.	
7·5 " Bastenne bitumen, at 0·38	2·85	
2·5 " Oil of resin at 0·42 . .	1·05	
6·0 " Sand, at 0·003 . .	0·18	
Total,	13·08 fr.	
As each cauldron produces 0·07 metre cube of the mastic, the metre superficial, 1 centimetre thick, costs		1·87 fr.
Warming the cauldrons, including the one in which the asphalte is pounded, ...		0·20
Carriage of plant to works		0·05
		2·25
Add 10 per cent for superintendence, &c.,		0·23
Total,		2·48 fr.

Or, the price per metre superficial, and per centimetre in thickness, is, as above, 2·48 francs; or, in round numbers, about $2\frac{1}{2}$*d.* per foot superficial.

But it must be observed, that in execution the real thickness exceeds the one theoretically assumed. Thus, if the rules be laid for a thickness of $1\frac{1}{8}$ inch in thickness, in fact it will be $1\frac{3}{8}$ inch, owing to an increase, towards the centre especially, which takes place at every pouring out of the liquid. The price will have to be augmented proportionally.

2. *When the Materials are used Cold; fragments of Asphalte and Soft Mastic being employed.*—The price per metre superficial may be estimated thus:—

22·50 kilogrammes of material, at 10 cents per kilog.	2·25 fr.
Breaking and preparation, ...	0·11
Use of tools and machinery, ...	0·03
Superintendence and costs, ...	0·24
Total,	2·63 fr.

Or, the price per metre superficial, and per centimetre in thickness, is, as above, 2·63 francs; or, in round numbers, about $2\frac{63}{100}$*d.* per foot superficial.

When the Materials are used Cold; but the Mastic used Soft, and the Silicious Stones covered with a Bituminous Gangue.—We have already seen, that to execute 1 metre superficial, and 1 centimetere in thickness, it requires about 12·15 kilogrammes of silicious stones, and 10·35 kilogrammes mastic, used either hot or cold.

The 12·15 kilog. silicious stones will cost about	0·10 fr.	
The 10·35 kilog. mastic consist of—		
5·64 kilogrammes Asphalte, at 0·10 fr.	0·56	
0·75 " Bastenne bitumen at 0·38	0·28	
0·20 " Oil of resin, at 0·42	0·08	
3·76 " Sand, at 0·003	0·01	
		1·03 fr.
Preparation and breakage of stones,		0·10
Heating mastic for ditto,		0·07
Carriage of tools and materials,		0·03
Superintendence and costs,		0·12
Total,		1·35 fr.

Or, the price per metre superficial, and per centimetre thick, of the roadway formed with silicious stones in a bituminous gangue, is, as above, 1·35 franc; or, per foot superficial, about $1\frac{35}{100}d$.

It would appear from this, that the latter mode of construction is notably more economical than the others.

To all these different prices, however, we must add the cost of forming the original foundation. As has been previously observed, a layer of broken stone, consisting of silicious materials, as clean as possible, resting upon a bed of sand, which shall have been perfectly aggregated, and proved by the ordinary traffic, is, at the same time, the simplest, the most economical, and the only one which offers sufficient guarantees of solidity. The price of such a layer of stone will vary, of course, according to the price of the stone itself. But if we assume it to be about $\frac{3}{4}d$. per foot superficial, we shall, in all probability, exceed the average.

Applying these prices to a roadway with a thickness of 4 centimetres ($1\frac{9}{16}$ inch,) the following will be the cost of the three different systems described:—

1. For a roadway laid with asphalte used hot,	10·67 fr.	per metre.
2. Ditto do. cold, with broken asphalte,	11·27	"
3. Ditto do. with silicious stones coated with a bituminous gangue,	6·19	"

CHAPTER X.—ON THE ANNUAL WEAR, AND THE EXPENSE OF MAINTENANCE, OF ROADWAYS IN BITUMEN.

We have seen that the action of traffic upon this description of roads is such as to produce but very trifling changes in their forms; and thus it would be natural to infer that, notwithstanding their want of hardness, they are not liable to be rapidly worn away. It becomes, then, very difficult to appreciate the degree of this action.

To ascertain this degree, borings were made in a portion of the roadway of the bridge of Saumur, about 21 feet 6 inches wide, after it had been in use for four years. The original thickness had been ascertained with the greatest exactitude at the time of its being laid down.

The thickness was originally	0.0425 met.
Mean ditto, after four years wear,	0·0398
The wear in that time was then	0·0027

It would thus appear that the annual rate of wear was rather under $\frac{7}{10}$ millimetre.

From careful observations, it was found that the daily average of the traffic over the bridge of Saumur is about 700 collars. The annual wear of bituminous roads may then be considered to be about 1 millimetre for every 1000 collars.

In ascertaining the number of collars, horses harnessed to every description of carriage have been counted indiscriminately, because, in the case under examination, the nature of these carriages, and the loads they bear, appear to influence the rate of wear very little. We have seen, in fact, that the pressure of the wheels only modifies the form of the roadway, without breaking it up, and that the horses' feet alone remove particles of its face. It seems probable that this action should be as destructive when horses are passing at a trot, and acting by percussion, as when they are drawing heavy loads at a smaller velocity. No account has been taken of horses not drawing, or of cattle, although—from the fact of the Cavalry School being close to the bridge, and also that Saumur is on the direct road traversed by the greater portion of the cattle sent from la Vendée to Paris—there are unusual numbers of both traversing the bridge every day. It may, therefore, be assumed, that the wear of this description of roadway does not exceed 1 millimetre per 1000 collars per annum, supposing that the wear takes place uniformly over the whole surface of the roadway.

The price of the repairs of the roadway of the bridge of Saumur was found to be 0·62 francs per metre linear, whilst the price of the maintenance of a similar surface of paved roads in the same district was found to have cost, in the same period, 0·78 francs per metre; but as the traffic on the paved roads did not attain the average of that upon the bridge, the comparison is unfavorable to the bituminous roads. If we compare the cost of the maintenance of ordinary macadamised roads, the advantage in favor of bitumen is still greater, for, with an equality of traffic, the latter would only cost about one-fourth of the former.

CHAPTER XI.—ROADWAYS COMPOSED OF PAVING STONES BEDDED IN BITUMEN.—APPLICATION TO SUBTERRANEAN PASSAGES, VAULTS, AND BASINS, OR IN STABLES.

In the different applications noticed hitherto, the bituminous substances are the only ones exposed to the direct action of the rolling traffic; they coat the stones entirely, and guarantee them from this action. In the application about to be noticed, the conditions are reversed. The stones receive the shock and the action of external agents; the mastic serves to bind them together.

The stones are prepared from 4 inches to 6 inches wide, from 8 inches to 12 inches long, and from 4 inches to 6 inches deep, and bedded in the mastic.

Upon a bed perfectly level, composed of cast iron plates, two iron bars from 26 to 33 feet long, $\frac{3}{8}$-inch thick, and of the depth to be given to the paving, are to be placed on edge. Their distance apart is to be such that three parallel lines of paving stones may be arranged between them, with joints of about 1 inch wide between each. They are to be maintained transversely by other bars, separating the intermediate space into compartments of from 2 feet to 2 feet 4 inches each; and the whole is to be bound together by stirrup irons, to prevent any displacement of the longitudinal bars.

In each of these compartments the three rows in question are to be placed with their dressed face downwards; the joints breaking alternately, and the transverse joints being made very close to one another. Small gauges, about 1¼ inches high, are to be placed between the longitudinal joints. When the stones are perfectly arranged, fine sand is introduced into the joints, so as to cover them entirely, and any sand upon the face of the stones exposed, to be removed.

It would unquestionably be preferable to employ, for the mastic, the materials already indicated; but as it is never likely to be in contact with the air, it is not exposed to any dangerous evaporation, and to diminish expense, may be composed of coal tar, fresh pounded lime, and sand. It must, however, be tried in the manner before described, and should not be used if the impression exceed 2 inches or 2¼ inches.

It is then to be poured into the joints of the paving, so as to fill them up to the average height of the latter. A quantity of broken stones are to be beaten into the mastic, in order to strengthen it, and to render its deformation more difficult. Lastly, whilst it still retains a certain degree of heat, a second layer of bitumen is applied, and carefully leveled by a gauge resting on the longitudinal bars. It is indispensable that the mastic in the joints should have completed its contraction in cooling before the second coat is added; because the thickness of the latter being so much less, a different rate would ensue, and the lower surface be very undulated.

The paving stones should be very clean and perfectly dry. To ensure the latter condition, and to cause them to adhere more perfectly with the mastic, they should be placed round the cauldrons before being used. For the same reasons, it is necessary that the works be carried on under a shed.

At the expiration of a few hours, the blocks thus prepared may be removed from their compartments, which operation may be more perfectly accomplished if the iron bars be covered by a greasy earth, or any substance to prevent adhesion to the mastic; they are then piled until wanted, observing always to place the first upon a cast iron plate, to prevent its changing its form.

These blocks are laid as follows. They are placed side by side, (leaving between them joints about ⅝-inch wide,) upon a form of broken stone, whose surface is to be regulated by a layer of sand of about ½-inch thick. The sand is to be carefully dressed by means of a rule and gauges, laid to the form of the roadway. After a short time, the blocks adapt themselves to the surface of the sand by their elasticity, and they are to be made to fit it more closely by being beaten with a mallet. The joints between the blocks are then to be filled in with mastic to about 1¼ inches from the surface. The joints between the stones have been kept open to the same depth by means of the fine sand during the preparation of the blocks; the next step to be taken is to fill in completely the joints parallel to the direction of the street; the transverse ones are left open to about a depth of two inches. This portion of the work must be executed with a mastic similar to the one indicated for the bituminous macadamised roads.

It will easily be understood, from the mode of construction above described, that the blocks present, at their lower surface, stones arranged with the greatest regularity, and according to a perfectly plane surface, similar to the one they immediately rest upon. But this is not the only condition necessary to ensure a perfect even roadway, for it is also necessary that the respective blocks should be of an uniform thickness. Care, then, must be taken that the gauge bars be of identical height.

It is not indispensable that the macadam should have been consolidated by traffic before being made to serve as the foundation of the roadway. It will be sufficient to roll or ram it carefully, and its thickness may be reduced to about 2 inches.

Should it not be considered necessary to render the roadway watertight, the joints between the blocks need not be filled with mastic to their whole depth. In this case, they are to be placed side by side, so as to touch one another completely. Fine sand is to be worked into the joints by a knife, to within 1¼ inches of the surface, and they are then to be filled in with mastic as before. Such paving should, however, be six inches thick.

Applications of this mode of Construction.—Its Advantages and Disadvantages.—The viaduct, of three arches, each of about 13 feet 10 inches openings, built near Saumur, on the Tours and Nantes Railway, for the National Road, No. 138, has been paved with blocks of the nature first described. The blocks are about 4½ inches deep, and each of them is formed by the assembling together of nine long stones in three rows of about 4 inches wide. They were placed on a bed of sand about ⅝-inch thick, and laid immediately upon the masonry. No mortar rendering was executed on the top of the extrados of the arches; so that the species of road covering of this bridge is only 5⅛ inches thick. As the depth of the arch at the key is only 1 foot 5¾ inches, the total thickness from the intrados to the surface of the roadway is only 1 foot 10⅞ inches, a result which could not otherwise be attained unless wood or iron beams had been used. The immediate vicinity of the bridge over the Loire imposed upon the engineer the necessity of not altering the level of the paving, and limited the height of the arch.

It would have been possible to have attained the object proposed by substituting, instead of this paving, a bituminous macadam laid upon an ordinary broken stone road; but it was feared that the masonry of the bridge would have been injured by the action of the rolling traffic during the consolidation of the form, and the less hazardous course described was adopted. The road was opened for traffic in 1846, and has preserved the viaduct from all infiltrations. Its success has been remarkable, and even after three years circulation it presented a perfectly even surface.

To obtain this result, however, it has been necessary to choose stones of very great hardness, whose rate of wear was very small, and, consequently, nearly even. Indeed, it must be evident, that as the stones which form this description of roadway are bound together by the mastic to a considerable depth, their displacement would be long and costly. Yet any depressions arising from inequalities in the wear must be repaired in this manner, for the connexion between all the stones prevents the application of ordinary modes of repair. The repairs of the subterranean works of a town would, from the same cause, become of very difficult execution.

This description of roadway has the additional disadvantage of being very expensive; it cost at Saumur about from 12 to 15 francs per metre superficial, or from 1*s.* to 1*s.* 3*d.* per foot. The bituminous macadam should then be used, unless very exceptional circumstances should call for the adoption of some particular description of paving.

A modification of this system was tried, in which the joints were only filled in with mastic to a depth of 1½ inches; but its success appears to have been doubtful, nor does any other result appear to have been attained than that of rendering the execution of the paving more complicated and more expensive.

(To be Continued.)

On the Progress of the Wave System of Naval Architecture. *By* JOHN SCOTT RUSSELL.*

The great interest taken by the British Association in this system at its origin, and the numerous experiments which they instituted for the purpose of establishing its truth, and of diffusing information upon it, have rendered it my duty to place on record each year those steps of progress which it has made in affecting the character of practical construction, and especially in giving to steam vessels increased speed, not only without a sacrifice of other good qualties, but with an increase of the sea-going requisites and mercantile points of excellence. At the last meeting I laid before this section an account of the successful introduction of the wave system into practice on several steam vessels and sailing vessels at Rio Janeiro, by Mr. Dodgson, who had found the system in all respects successful, and that the vessels he had built on it had beaten their competitors on the old system. Since that time a treatise on naval architecture, published in America, has been transmitted to this country. It contains drawings of many of the most recent and celebrated vessels constructed in that country. The author of that treatise does not hesitate to avow frankly the general adoption of the principles of the wave system, by the builders of the best and fastest vessels in America. He gives accurate drawings, which are evidently made in accordance with it.

He quotes experiments as high as twenty-four miles an hour, which speed has been attained by its use. He unhesitatingly declares his own implicit belief in the system and entire adoption of it. In our own country the most eminent builders of fast steam vessels continue to adopt the most prominent characteristics of the wave system, viz., hollow water lines for the bow, much fuller water lines abaft than forward—the greatest breadth nearer the stern than the bow. I am not sure how far the builders of these vessels would wish it to be understood that they do adopt the wave system; and I shall, therefore, confine my further observations to vessels which have been built under my own immediate care. During the last year an opportunity has presented itself of obtaining one of the most decided practical experiments on a larger scale regarding the excellence of the new form for steam vessels. It is very rare that in ordinary practice one can obtain an experiment which will exactly determine the relative merits of two different forms of ships; because there is generally some diversity in the application of the power or in the circumstances, as, for example, a difference between the excellence of the engines, which affect materially the result, and which is quite independent of the qualities of the ship.

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* From the London Architect for August, 1851.

But if one could get an experiment of the following nature. If one could take a steam engine of a given power, and supply it with as much steam of a given pressure as the engines could use; and a given pair of paddle-wheels, so as to apply that power in exactly the same way in both cases, and having first tried these engines in a ship built on the old system, if one could then simply take these engines out of that vessel and place them in one built on the new system, of equal or greater tonnage, then if the new vessel, being tried in similar circumstances, should be found to excel the old one, we should have a result in a practical form which could not fail to be satisfactory. Such is the experiment which has just been obtained on a sufficiently large scale to be entirely conclusive. A pair of marine engines of 220 horse power had been working on board a wooden steam vessel of 450 tons, being a proportion of one horse power to two tons nearly. The beam of the vessel was 24 feet, and her draft of water 9 feet. This vessel was built on the old system, according to his own plan, by one of the most eminent builders of steam vessels.

This vessel was placed on the line between London and Antwerp, and realized a maximum speed of ten miles an hour. These engines, with the same paddle wheels, were then taken out of the vessel, and were placed in a new iron vessel, built upon the wave system, by Messrs. Robinson and myself. This vessel was of larger beam and greater length of body than the former, being 570 tons, with 25 feet beam and 9 feet draft. The experiment has now been tried with the same old engines, but repaired and furnished with new boilers capable of supplying the full amount of steam to the engines. The result has been conclusive. The vessel has not been made unusually sharp or fine, but, on the contrary, is a capacious sea-going vessel, with capacity for 150 tons of cargo more than the former vessel. The new form of vessel with the old engines has attained a maximum speed of 15 miles an hour—being a clear gain of speed of five miles an hour. It is important to observe, that where speed is obtained by improved shape of vessel, it is obtained at the least possible first cost and greatest economy in daily use. I have next to report during the past year the first application of the wave system to the construction of war steamers. It had long been supposed that owing to the fineness of water lines of the bows of vessels built on the wave system, it would not be possible for them to carry the same amount of heavy ordnance calculated to fire in a line with the keel as in vessels of the ordinary construction. Even in these it is difficult to carry so large an armament in proportion to tonnage as desirable. It has been repeatedly urged as an objection to the wave formed vessels, that they would not carry a heavy armament. During last year, however, two war steamers have been constructed for a foreign government, of 500 tons, and 160 horse power, upon the wave system, by Messrs Robinson and Russell. They have been fully armed, stored with provisions and fuel, and tried by a naval commissiom at sea; and have been accepted as having fulfilled the following conditions of their construction, viz., that they were to carry double the armament of any war steamer of the same tonnage and power in her Majesty's navy, and go two knots an hour faster than any vessel in her Majesty's navy. Dimensions, power, armament, &c.; Vessels 165 feet long, 26 feet wide, 500 tons; engines, 48 inches diameter, 4 ft. 6 in. stroke, 160 horse power; armament, four 8 inch guns, 9 ft. 6 in. long; ammunition, 100 rounds; fuel, 2000 miles steaming; speed, 15 miles an hour light, 13 miles an hour loaded. I have last to report the trials during the past winter of a yacht, the *Titania*, built for Robert Stephenson, Esq., the eminent engineer, who had confidence enough in the wave system to give it a fair trial on a sailing schooner which he sent round during last winter by the Bay of Biscay to Alexandria, and in which he encountered severe hurricanes in the Mediterranean. The results of the experiments are, that the war vessel has been found to be in every respect, a good sea boat; and contrary to the expectations of many who fancied that the fine bows of wave vessels were only good for fair weather sailing, it has turned out that while in light airs and smooth water, vessels of a lighter build and larger sails may pass the *Titania*, yet that, in any weather stronger than a light breeze, she has beat every vessel she has encountered, including yachts of high reputation and larger tonnage. It thus appears that during 1850–51, very considerable progress has been made in the introduction of the wave principle into practical use.

For the Journal of the Franklin Institute.

Rule for Calculating the Weight that can be safely trusted upon a Pile which is driven for the Foundation of a Heavy Structure. By John Sanders, *Brev. Maj. U. S. Eng.*

A simple empirical rule, derived from an extensive series of experiments in pile driving, made in establishing the foundation for Fort Delaware, will doubtless prove acceptable to such constructors and builders as may have to resort to the use of piles, without having an opportunity of making similar researches. I believe that full confidence may be placed in the correctness of this rule, but I am not at present prepared to offer a statement of the facts and theory upon which it is founded.

Suppose a pile to be driven, until it meets such an uniform resistance as is indicated by slight and nearly equal penetrations, for several successive blows of the ram; and that this is done with a heavy ram, (its weight at least exceeding that of the pile,) made to fall from such a height that the force of its blow will not be spent in merely overcoming the inertion of the pile, but at the same time not from so great a height as to generate a force which would expend itself in crushing the fibres of the head of the pile. In such a case it will be found that the pile will safely bear, without danger of further subsidence, "*as many times the weight of the ram, as the distance which the pile is sunk the last blow, is contained in the distance which the ram falls in making that blow, divided by eight.*" For example, let us take a practical case in which the ram weighs one ton and falls six feet, and in which the pile is sunk half an inch by the last blow; then as half an inch is contained 144 times in 72 inches, the height the ram falls, if we divide 144 by 8, the quotient obtained, 18, gives the number of tons which may be built with perfect safety, in the form of a wall, upon such a pile.

Fort Delaware, September 27th, 1851.

AMERICAN PATENTS.

List of American Patents which issued from September, 16, *to October* 7, 1851, (*inclusive*,) *with Exemplifications by* Charles M. Keller, *late Chief Examiner of Patents in the U. S. Patent Office.*

29. For an *Improvement in the Manufacture of Iron;* Samuel T. Jones, City of New York, September 16; patented in England July 23, 1850.

"My invention consists in the application of the ore called Franklinite, to the preparation or manufacture of iron from its ores, or in the finery, bolling, puddling, &c., of crude or pig iron."

Claim.—"Having thus fully described the nature of my invention, what I claim as new therein is, the application of Franklinite to the improvement of iron, in the process of reduction from its ores, and in the finery or puddling of crude or pig iron, according to the methods as above described."

30. For an *Improvement in Bedsteads;* Ira Russell, Dedham, Massachusetts, September 16.

Claim.—"What I claim as my improvement is, the suspension spring or strip, the thrust spring, and the spring between them, as combined or applied together, and to the bedstead and slats imposed upon them, substantially as herein before specified."

31. For an *Improvement in Railroad Car Coupling;* George Winters, Portsmouth, Pennsylvania, September 16.

"The nature of my invention is a useful improvement in the shape and construction of a car platform, in combination with a jointed self-acting pin and stationary pin, for coupling and disconnecting cars."

Claim.—"What I claim as my invention is, the shape and construction of the improved car platform, in combination with the jointed self-acting pin, stationary pin, and grooved half coupling, all as herein described, for the purpose of coupling and disconnecting cars."

32. For an *Improvement in Machines for Breaking Hemp and Flax, and Reducing the Length of the Fibres;* James S. Treat and Stephen Randall, Voluntown, Connecticut, September 16.

"The nature of our invention consists in an entirely new method of reducing flax, either in the straw or otherwise, to suitable length of staple, separating the woody substance from the fibres, by one operation, which we accomplish by means of a series of grooved or otherwise graduated rollers, so arranged and geared, decreasing in size and varying in speed, as to separate the fibres, and prepare it for the carding and spinning machinery, whether the machinery be constructed as hereinafter described and represented, or in any other manner substantially the same in principle and operation, whereby the same result is accomplished."

Claim.—"Having thus fully described our invention, what we claim therein is, the art or method of separating the fibres of flax, hemp, &c., from the boon, and reducing them to suitable length of staple, to be used on cotton, woolen, and other machinery, by the use of combined sets of grooved and graduated rollers, or their equivalents, operating in the manner and for the purpose herein fully set forth and represented."

33. For a *Gauge for Indicating Pressure of Steam, &c.;* George Faber, Canton, Ohio, September 16.

"This invention is for the purpose of ascertaining the degree of pressure to which elastic fluids are subjected under certain circumstances; as, for example, in the generation of steam in ordinary steam boilers; and is chiefly intended for application to such boilers. The principle upon which the invention is based, is the power produced by a free current of an elastic fluid impinging upon an inelastic substance, as a disk of metal, &c., the velocity or pressure being ascertained by the distance the disk has been moved by the force of the current."

Claim.—"What I claim as my invention is, combining with the steam tube, the disk and spring, so arranged that the force of the current of steam impinging upon said disk, can be ascertained by the extent to which the spring is expanded, and thus can be known the comparative pressure in the boiler or other vessel, necessary to give the required velocity to the current, to produce different degrees of expansion of the spring, substantially as herein set forth."

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34. For an *Improvement in Apparatus for Draining Sugar;* Smith Gardner, City of New York, September 16.

"The nature of my invention consists in arranging one or more series of pans, with their bottoms perforated or made of wire gauze, and each provided with a pan or receiver below, to catch the molasses; and provided with an aperture for the passage of the current of air; the whole being otherwise made air-tight, so that the current of air forced into the first shall, in producing the required effect, pass to the second, to produce a like effect there; thence to the third, and so on throughout the series, and thence in like manner through other series, if desired."

Claim.—"What I claim as my invention is, combining two or more straining pans with molasses or receiving vessels below each, substantially as described; the said pans being provided with a discharge pipe or tube, substantially as described, so that the current of air shall pass from the lower part of the first to the upper part of the next, through the series, and so arranged as to retain the molasses or other liquid parts; and this combination I claim, whether the said succession of pans be used in one or more series, as described."

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35. For an *Improvement in Stone Drilling Machines;* Henry Goulding, Boston, Massachusetts, September 16.

Claim.—"Having thus described my new drilling machine, I shall state my claim as follows: What I claim as my invention is, 1st, A power-drilling machine, in which the drill is driven by a vibrating hammer, operated substantially as herein above described.

"2d, I claim stopping the "feeding forward" of the sliding frame and drill, when the latter does not penetrate the rock sufficiently, or to the usual depth, at each blow, by keeping the pawl out of the feeding ratchet, excepting when the drill goes in the requisite length, by means of the combination of the forked vertical lever, connected with the drill shaft, the horizontal lever, and the spiral spring, operating substantially as herein above set forth.

"I also claim, drawing the edge of the drill away from the bottom of the hole, when the tool is being turned, by means of the inclined claw or fork, operating with a collar on said drill, substantially as herein above described."

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36. For an *Improvement in Machines for Dressing Millstones;* Erastus W. Hazard, Binghampton, and Charles H. Jenner, Rochester, New York, September 16.

"Our invention consists in combining with the lever which operates the feed hand or hands, and which receives motion from a rotating cam or tappet, a weighted lever, or the equivalent thereof, which falls by its weight the moment the lever is carried back to give one feed motion, so that the end thereof shall act as a stop to arrest the feed motion, that the cutter may continue to strike in the same place, until the attendant lifts up the lever to permit the feed motion to continue."

Claim.—"We claim, in combination with the feed lever operated by the cam to work the feed bands, the employment of a weighted stop lever, or the equivalent thereof, acting in the notch of the lever, substantially as described, which said stop shall be self-acting, to stop the feed motion, that the cuts may continue in the same place, until the feed motion is re-started, and thus insure the cutting of the stone to the required depth, whatever may be the texture thereof, as described."

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37. For an *Improvement in Processes of Making Bronze Powder;* Leopold Brandeis, City of New York, September 16.

"The nature of my invention consists in producing the powder, by rolling it between steel or iron tempered rollers, instead of the old producing (kept secret), to beat the metal to dutch leaf, and grinding it, to give it a bright and brilliant surface, by covering the bronze with soap, instead of grease and oil, and polishing the surface by application of polished rollers."

Claim.—"What I claim as my invention is, making metallic bronze powder of copper, tin, spelter, or their alloys, by running them through iron or steel rollers, substantially as described. Also, the application and manner of application of soap, to make the bronze bright, and brilliant, and durable."

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38. For an *Improvement in Stoves;* Gardner Chilson, Boston, Massachusetts, September 16.

Claim.—"What I claim as my invention is, forming the tapering radiator, produced by extending the fire chamber, as above set forth, in branches arranged with their centre lines parallel to each other, or nearly so, and connected by arches, substantially in the manner above set forth."

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39. For an *Improved Bench Vice;* N. F. Cone, Kingsville, Ohio, September 16.

Claim.—"What I claim as my invention is, the combination of the latch pin, the ratch bar acted upon by a spring that constantly tends to disengage it from the latch pin, and the foot lever, with the movable jaw of a vise; these several parts being constructed, arranged, and operating as herein set forth."

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40. For an *Improvement in Weavers' Temples;* Arnold Jillson, Woonsocket, Rhode Island, September 16.

Claim.—"What I claim as my invention is, connecting the movable jaw to its point of suspension, by an arm, or equivalent, in such a manner that the point of suspension will be nearer the middle of the cloth than its other extremity, which extends out towards or beyond the selvedge at such an angle, that the jaws of the temple will be released by the cloth, as it is spread by the action of the reed upon the warp, when it strikes up a thread of weft, and closed by the contraction of the cloth, caused by its own elasticity, as the reed leaves it; so that the cloth, by its own action, is released when the reed advances, and is griped and held as it recedes; thereby dispensing with the strong spring, wedge, and other devices, heretofore used for operating the jaws of temples."

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41. For an *Improvement in Leather Splitting Machines;* Alpha Richardson, North Enfield, New Hampshire, September 16.

Claim.—"Having thus described my improved leather splitting machine, I shall state my claim as follows:

"1st, Making the gauge roller of a leather splitting machine, with the sectional tubes or friction rollers, to be placed on each end thereof, substantially as herein above set forth, and for the purpose specified.

"2d, I claim combining with the ordinary cast iron spring plate of a leather splitting machine, a cast steel spring plate, forming a double lip spring plate, and fitted thereon, so as to be adjustable horizontally, as herein above set forth, and so that the front edge of the lower or cast iron plate may project under the edge of the knife, and hold up the split, as herein above set forth."

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42. For an *Improvement in Fastenings for Last Blocks;* Levi R. Rockwood, Assignor to Joseph L. Woodward, Upton, Massachusetts, September 16.

Claim.—"Having thus described my improvement, what I claim as my invention is, fastening the block to a boot or shoe last, by a hasp on said block, in combination with a spring attached to the last, as herein above described, or in any other manner substantially the same."

43. For an *Improvement in Waste Pickers;* Charles G. Sargent and Robert Thompson, Lowell, Massachusetts, September 16.

"The object of our improved machine is, to separate or reduce yarn, cloth, woolen, or cotton rags, or waste, to their original or primary condition of fibre, and to straighten the fibres out."

Claim.—"Having thus described our improved machine, what we claim as our invention is, the use of a blast of steam or air, passing into and out of the hollow shell, as herein above specified, so as to blow the ends or fibres of the material out, in order to enable the teeth of the picking cylinder to engage with them."

44. For an *Improvement in Machines for Printing House Paper;* Milton D. Whipple, Assignor to The Essex Company, Lowell, Massachusetts, September 16.

"The great object which is attained by my machinery is, preserving "the register" (so to speak) in printing house paper, so that in printing several colors with different blocks, the patterns shall appositely fit each other, or be printed in accurate relative positions."

Claim.—"Having thus described my improvements in house paper printing machinery, what I claim as my invention is, the use of two sets of spur clamps, one set being sliding and feeding clamps, and the other set being stationary and holding clamps; and the two sets having a connected operation, so that one set shall be open when the other set is closed, all as herein above set forth.

"I also claim the mode herein above described, for supplying the coloring fluid to the patterns; that is, by means of a cloth band, alternately drawn forward from the vat, over an elastic bed, on which the platen descends, and then back again, through the color in the said vat, all as herein above set forth.

"I also claim, giving the second or double application of the color to the patterns, for each impression, by suddenly lowering the elastic bed, after the first touch of the patterns on the cloth band, and then raising it again for the second touch, substantially in the manner herein above set forth."

45. For an *Improvement in Churns;* George B. Clarke, Leonardsville, New York, September 23.

Claim.—"1st, I claim the employment of a revolving vessel, containing the cream or milk, with or without cleats, constructed either plain or with pins, or having any other suitable internal projections, and operating in combination with a toothed or plain stationary cross bar, removably or permanently secured to the fixed axles, and situated in the space forming the upper half of the vessel, at any desired distance from the centre thereof.

"2d, I likewise claim the employment of a temporary cylinder and tubes, in combination with the revolving vessel and cross bar, for cooling, or warming, and agitating the milk, by its precipitation thereon, as caused by the circular motion conveyed to the milk, and interrupting or arresting effect produced, substantially as shown and described."

46. For *Improvements in Machines for Scutching and Hackling Hemp and Flax;* Owen W. Grimes, Paducah, Kentucky, September 23.

"The nature of my invention consists in the manner of throwing the teeth in and out of the drum, with which they revolve, to any desired distance, while the machine is in operation, so as to give more or less hold on the hemp or other material, or drawing them entirely within the drum, when the material becomes entangled, and liable to choke or break up the machine; and also the method of allowing the teeth, when out, to fall back, or yield sufficiently far to allow the material to slip over them, when too great a strain is suddenly brought upon them, and recovering their proper position again after passing said obstruction."

Claim.—"Having thus fully described my invention, what I claim therein as new is, the method herein described, or any other means essentially the same, of throwing the teeth in and out of the cylinder or drum, at pleasure, whilst in motion, so as to present a greater or less length of teeth to the hemp, or drawing them entirely within the cylinder, in case the hemp should become entangled, and likely to break up the machine.

"2d, I claim, in combination with the bar holding the teeth, the spiral spring, for allowing said bar to yield to knots or other obstructions, and for drawing back into proper position the said bar, after it is released from said obstruction.

3d, I claim, in combination with the bar and teeth arranged as herein described, the adjustable guides, for setting the teeth at such angle as will give them more or less hold upon the hemp, as herein fully described and represented."

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47. For *Improvements in Machines for Stripping Seed from Broom Corn;* L. D. Grosvenor, South Groton, Massachusetts, September 23.

Claim.—"Having thus described the nature and operation of my invention, what I claim as new is, the endless bearded belt, constructed of any proper material, and having "lugs" or spikes as described, in combination with the comb rollers, set diagonally upon the frame, in the manner and for the purposes substantially as set forth."

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48. For an *Improvement in Lath Machines;* William Merrell, Randolph, Ohio, September 23.

"The nature of my invention consists in a long horizontal frame, having a rotary saw hung upon a spindle placed transversely upon it, near its centre; upon the top of the front part of the frame a suitable table or bed is provided, for the purpose of receiving the slab or stuff from which the laths are to be cut, which is fed to the saw by feed rollers; near the top end of the frame is a contrivance (to be hereinafter described) for throwing out each lath immediately after it is cut off, and throwing down the slab or stuff to a series of rollers, which return it to the bottom end of the frame, where the attendant stands to receive it, and place it again on the table for another cut; the saw has a cutter attached to and rotating with it, for the purpose of planing, or giving any required bevel or form to the edge of the lath, at the same time that it is being cut off."

Claim.—"Having thus fully described my invention for sawing laths, I desire it to be understood, that I do not claim mounting a rotary cutter on the same spindle of the rotary saw, as herein described; nor do I claim the returning table, consisting of a series of rollers, arranged and operated in the manner described. But what I do claim is, the director and carrying belt, in combination with the apparatus for registering, substantially such as described, for delivering bundles ready counted.

"I also claim the rounded surface of the receiving table, in conjunction with the bent form of the strip, as represented in fig. 2, at *k*, which effects in the simplest manner the delivery on the returning rollers of the unsawed slab to the attendant for another cut."

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49. For an *Improvement in Easy Chairs for Invalids, &c.;* Patrick O'Neil, Brooklyn, New York, September 23.

Claim.—"Having described the construction and uses of my adjustable combination chair, what I claim therein as new is, the manner of combining the jointed chair with the jointed ottomans, whereby the whole is made to subserve the several purposes herein before described, and illustrated in the drawings.

"I also claim furnishing the back of the chair with an additional joint, whereby the back of the chair is rendered susceptible of such adjustment as to form a support to the spine of the occupant of the chair, as described and shown in the drawings.

"I likewise claim the employment of the triple jointed hinges, in combination with the spiral springs, for securing the flexible bolster, by which it is steadied and retained in its proper position, when expanded and contracted, as set forth."

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50. For an *Improvement in Ventilating Ships;* Amos J. Sexton, Brooklyn, New York, and William Ennis, City of New York, September 23.

Claim.—"We do not claim to have invented either the caboose, water back ventiducts, or valves, although we do not know of the several parts referred to having been used for the purpose described; but what we do claim as our joint invention is, the combination and application of the caboose, water back ventiducts and valves, in connexion with our water surface and the cowl and vane, for the introduction of pure air and the expelling of impure air, as described, and for the purpose herein before mentioned."

51. For an *Improvement in Machinery for Threading Wood Screws, and Feed Apparatus therefor;* Thomas J. Sloan, City of New York, September 23.

Claim.—"What I claim as my invention is, the employment of two cams in combination, substantially as described, for the purpose of operating the fingers which supply and present the blanks to the griping jaws, as described.

"I also claim the employment of one cutter to form thread on the conical point, when combined and operating simultaneously with a second cutter, for forming the thread on the main part of the shank, substantially as described and for the end specified, provided the motion of one of the cutters is extended into the track of the other, to ensure the making of the thread on the conical point a continuation of the thread on the main part of the shank."

52. For an *Engine, in which Compressed Air or other Gas, Heated and Expanded by Admixture therewith of a Heated Fluid, is used as a Motive Agent;* William Mt. Storm, City of New York, September 23.

Claim.—"Having thus fully described the nature of my invention, what I claim is, actuating an engine, such as are now usually driven by steam, or of any convenient form, by means of a measured or detailed quantity of air, previously compressed, and having had its tension due to such compression, highly increased and augmented, by the jetting or flashing into or commixture with it of a measured or detailed quantity of a "medium," or, in other words, of a heated liquid, as water, or a vapor (simple or super-heated) as steam; said jetting of the steam into the air, (or vice versa, the air into the steam, which I claim as equivalent,) and their commixture, being effected in a vessel or vessels disconnected previous to and during that process, or at least prior to its final consummation, from the reservoir or main source of compressed air, and from that of the steam, &c., and each separate and distinct charge or detailed quantity of compressed air, heated by its corresponding charge or detailed quantity of steam, being allowed to act upon the piston, or its equivalent, prior to the admission or introduction of another charge of air and steam into the vessel or vessels in which their commixture is effected; the whole operation being carried out by means of mechanism, in substance such as here represented, or any more fitting mechanism that shall effect the same in the manner here claimed."

53. For an *Improvement in Shoe Latchets;* Isaac Banister, Newark, New Jersey, September 23.

"The nature of my invention consists in attaching to a flap, which passes over the instep, and is connected to one of the quarters of a shoe, a thin flexible plate or latch, which is curved at its front end, for fitting into a socket or eyelet, secured between the lining and upper leather of the vamp of a shoe, and at the other end projects beyond the said flap a sufficient distance to enable it to be passed under a catch or hook, which is secured to the opposite quarter of the shoe, and serves by its action on the latch, to confine the shoe firmly to the foot."

Claim.—"What I claim as my invention is, the confining a shoe to the foot by means of a flexible latch, secured to one portion of the said shoe, acting in conjunction with a socket or eyelet and a catch or hook, secured to other parts of the shoe, and operating substantially in the manner herein set forth."

54. For an *Improvement in the Churn and Butter Worker;* Asa Willard, Boston, Massachusetts, September 23.

Claim.—"I claim the combination of one or more fluted rollers, with one or more floats, to operate so as not only to aid in the process of separating the butter from the cream, but afterwards, and when the motion of the dasher is reversed, to throw into ridges the butter spread on the bottom of the floats.

"And I claim the improvement of giving a longitudinal hollow or curve to the external surface of each float, for the purpose of gathering the spread butter towards its middle, and preventing the butter from adhering to the ends of the reservoir, as specified."

55. For an *Improvement in Piano Fortes;* Louis H. Brown, Boston, Massachusetts, September 23.

Claim.—"Having thus described my improvements, what I claim as my invention is, 1st, arranging the sounding board in a springing form, and supporting its back on a straining lever, made to bear with more or less force against it, in the manner and for the purpose herein above specified.

"2d, I claim the combination of the short subsidiary iron frame, having a rectangular socket on its front rail, with the long main iron frame, having a wooden block on the under side of its front rail, which fits and is glued into the aforesaid socket, as herein before set forth.

"3d, I claim casting the bridge of the long iron frame with curved brackets, so as to have it raised above the level of the bottom of the front rail of said frame, and permit the strings to be strained or strung under the same, as herein above explained.

"4th, I claim easing the escapement of the fly of the jack from under the centre block of the hammer, by means of a spring, combined with said block and the stem of the hammer, as herein above stated.

"5th, I claim arranging the back catch on a lever, having a fulcrum in the jack, and arranged so as to cause the catch to follow the hammer in a stroke of the same, and cause it to repeat the stroke or note, if desired, when the fly of the jack fails to operate, so as to effect said second stroke.

"6th, I claim using a piece of gutta percha on the top of the hammer head, in lieu of some of the layers of leather, in the manner and for the purpose specified."

56. For an *Improvement in Letter Stamps;* Benjamin Chambers, Washington, D. C., September 23.

"The purpose of my invention is to furnish a stamp, having a simple and ready mode of discharging the movable letters and figures containing the date of the stamp, while preserving the integrity of the cylindrical metallic or other block containing the fixed letters, and avoiding the cutting away and weakening of the handles."

Claim.—"I do not claim punching out types from a cavity by a follower; but what I do claim as my invention is, so making and operating the detruding rods or followers of a letter stamp, as to act wholly within the body of the stamp block, whereby I avoid cutting away the handle, and the weakening which would be caused thereby.

"I also claim making the detruding rod, wing, and thumb slide in a single piece, whereby I greatly economize the labor of making this part of the stamp, as herein set forth."

57. For an *Improvement in Attaching Cutter Bars to Harvesters;* John H. Manny, Waddain's Grove, Illinois, September 23.

Claim.—"What I claim as my invention is, hanging the cutter bar of a reaping machine to the side of a triangular frame, in such manner that neither extremity of the cutter shall be liable to sag below the other extremity, as herein set forth."

58. For an *Improvement in Printing Presses;* Jacob Worms, Paris, France, Assignor to Jacob Phalen, City of New York, September 23; patented in France (in part) May 19, 1849, and (in part) September 27, 1849.

"My invention may be summarily designated as the printing with rapidity, either in ink or colors, by the aid of certain apparatus herein described, a continuous sheet of paper or stuff, on one or both sides, and of cutting and folding the same."

Claim.—"Having now described fully the nature of my invention and its application, I will here observe, that engraved or sunken cylinders have been already used for the printing of woven fabrics, but these are very expensive to manufacture, compared with the cylinders prepared as I have described. I wish it also to be understood, that in the apparatus described, I do not confine myself to the exact details herein set forth, for these must necessarily vary with the size of the matter to be printed, or with the greater or less rapidity with which the movements are to be executed. It must also be understood, that I do not claim, individually or separately, any of the parts of the apparatus or machinery.

"But what I do claim as my invention is, 1st, In combination with the ink troughs, E, and printing cylinders, A, the arrangement of the cam cylinders, D, reciprocating cylinders, K, (operated by the levers, J,) and L, (operated by the levers, M,) and cylinders, G and N, for receiving, carrying, and distributing the ink from the said trough to the said cylinders.

"2d, I claim, in combination with the printing cylinders, the cylinders, O P, provided with a spring knife or saw, operated by cams, and also with alternate ribs or projections and grooves, for the purpose of nearly severing the filaments of the paper, as it passes through between said rollers, and for the purpose also of creasing the paper, for the more easily folding of it.

"3d, I claim, in combination with the partially cutting and creasing cylinders, O P, the different sized cylinders, C D, geared together, for the purpose of tearing apart the partially cut paper—the cylinders, C, holding, and the increased motion of the cylinders, D, at their periphery (they being the larger) drawing the paper sufficiently to separate it.

"4th, I claim, in combination with the separating cylinders, C D, the tunnel, G, for guiding, and the wheel, E, divided into a suitable number of compartments, for receiving the sheets as they are delivered from the machine; the whole being constructed substantially as herein described, and for the purposes fully set forth."

59. *For Blind or Shutter Fasteners;* Washburn Race, Seneca Falls, New York, September 23.

Claim.—"What I claim as my invention is, the combination of the fast and free hooks with the inner plate, the same being arranged as herein set forth, in such manner that the fast hook forms the pivot for the free one, and the two are connected to the inner plate in such manner that the movement, breakage, or removal of the free hook does not affect the security of the fastening, while at the same time the two hooks are secured to the inner plate, by the fastening of the latter to the shutter."

60. For an *Improvement in Hand Stamps;* Stephen P. Ruggles, Boston, Massachusetts, September 23.

"The nature of my invention consists in so constructing a hand stamp, that by moving it in the arc of a circle, such as would be naturally made by the rising and falling of the arm, it will still come down upon the paper at all points of its surface, although it may strike at an angle with the plane upon which the material to be stamped is placed, and at all times make a fair and perfect impression, whether moved in a perpendicular or oblique line to the same."

Claim.—"Having thus fully described the nature of my invention, what I claim therein as new is, securing the plate of a hand stamp to the shank or handle, by means of a universal ball and socket, or other joint, so as to allow the stamp to make a fair impression, at whatever angle it may strike the material to be stamped, as herein fully set forth and explained."

61. For an *Improvement in Piano Fortes;* Timothy Gilbert, Boston, Massachusetts, September 30.

Claim.—"What I claim as my invention is, the combination of the return screw and button, or equivalent contrivance or contrivances, with the hammer and fly, and its retractive spring, so as to operate in manner and in connexion with the same and other parts, substantially as herein described."

62. For an *Improvement in Weavers' Shuttles;* Laroy Litchfield, South Bridge, Massachusetts, September 30.

"My invention consists in forming the spindle, the spring, and the catch, all in one piece, for the purpose of cheapening the construction, and lessening the liability to get out of repair; and in providing the shuttle with a pin, inserted transversely or parallel to the pin on which the spindle plays, for the purpose of throwing back the spring and catch, and releasing the bobbin when the spindle is turned up from the mouth of the shuttle."

Claim.—"What I claim as my invention is, making the spindle and spring both in one piece, by extending the spindle behind the hole, for the pin that fastens it into the shuttle, and reducing it to a proper thickness, and bending it to form the spring required to hold the spindle in its proper positions in the shuttle, either with or without the catch on the end of the spring, in combination with the pin or its equivalent, against which the spring acts, to hold the spindle in the different positions required, substantially as described, thereby avoiding the inconvenience arising from the loosening of the screw which holds the spring in other shuttles, and saving the additional labor required to fit it in, when the spring is made separate from the spindle."

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63 For an *Improvement in Weighing Carts;* Norman B. Livingston, Portland, Indiana, September 30.

Claim.—"Having thus fully, clearly, and exactly described the nature, construction, and operation of my improved weighing car, what I claim therein as new, is, the construction and arrangement, substantially as described, by which a weighing apparatus is capacitated for easy removal from place to place, by the adaptation to each other of the containing and weighing apparatus and of the running gear; that is to say, by making the fulcra for the lever or weighing beam upon the axle near the wheel; the arm, with its sliding weight, lying upon the pole or tongue, and the axle affording, by its bent form, free access to the contents of the box, when discharged, by means of the valve."

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64. For an *Improvement in Self Acting Presses;* Wm. Moore, Belville, Ohio, September 30.

Claim.—"Having thus described the construction of my press, I desire it to be understood that I do not claim either the cams, or the temple joint, when used singly; but what I claim as new is, the combination of the eccentric cams rolling on each other, so as to avoid friction, in connexion with the braces, or temple joint, as above described, for the purpose and substantially in the manner aforesaid."

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65. For an *Improvement in Saws for Sawing and Smoothing Boards;* Geo. F. Woolston, District of Orangeburg, South Carolina, September 30.

Claim.—"I claim for the purposes above set forth, forming and arranging teeth of saws substantially as herein described."

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66. For an *Improvement in Instruments for the Cure of Stammering;* Robert Bates, Philadelphia, Pennsylvania, September 30.

"The nature of my invention consists in the employment of a tube in the mouth, for the passage of air from the mouth, when the muscles that close the orifice of the mouth, and stop the egress of air, in speaking, are suddenly contracted by spasmodic action; and in the employment of a strap around the throat, provided with a spring pad, regulated by a screw, which pad presses against the throat, and keeps the glottis or larynx of the throat open, thereby allowing a free passage of air through the throat and mouth, from the lungs; the arrest of which air, by the spasmodic action of the throat and mouth, causes stammering, and its escape by means of my instrument, cures the spasmodic action, and consequently cures stammering."

Claim.—"Having thus fully described my instruments for the cure of stammering, and their application and method of use, what I claim as my invention is, 1st, the employment of a tube in the mouth, which will admit of speaking, and of the passage of air, when either the tongue or lips would prevent the passage of air, substantially as herein above set forth.

"2d, The employment of the adjustable spring pad, substantially as herein above set forth.

"3d, The joint employment of the mouth tube and the adjustable spring pad, at the same time curing the guttural, lingual, and labial disease of stammering, substantially as herein above set forth."

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67. For a *Machine for Making Wheel Tires;* Maria Vaughn, Greenbush, New York, Administratrix of Joseph C. Vaughn, deceased, Assignor to James C. Bell, Greenbush, New York, and Robert Christie, Jr., of the City of New York, September 30.

Claim.—"What I desire to claim is, the combination of the upper and lower dies, with the welders, receiving motion from wedges attached to the upper and falling die;

the whole acting to shape a tire on all parts of its surface at the same time, substantially as described in the within specification."

68. For an *Improved Maze Lock;* Thomas Nicholson, Falmouth, Virginia, September 30

Claim.—"What I claim as my invention is, the disk with its concentric and radial passages, or their equivalents, in combination with the bolt end, operated substantially in the manner and for the purposes herein described."

69. For a *Machine for Arranging Screw Blanks and Articles of a Similar Character;* Thomas J. Sloan, City of New York, September 30.

"The nature of my invention consists in combining two inclined stationary ways with a movable trough, formed of oppositely inclined surfaces, provided with a pin or pins, or their equivalents, that pass between the ways, the lower end of the said ways extending down to or below the surface of the said trough, so that as the said trough, with its pin or pins, is set in motion towards the ways, the screws, or other articles to be arranged and delivered, will be carried on to the ways, and such of them as are found with their shanks between the ways, will be carried or forced up the inclined ways to the delivery end."

Claim.—"Having thus described the principle or mode of operation of my said invention, and the manner of constructing and using the same, I wish it to be distinctly understood, that I do not limit myself to the precise mode of construction and arrangement specified, as these may be varied, without changing the character of my invention. What I claim as new is, the combination of the inclined ways, substantially such as herein described, with a trough, substantially such as described, and provided with a pin or pins, or their equivalent, as described, so that by the motion of the trough towards the ways, or vice versa, the screws or other articles will be forced up the inclined ways, hanging by their heads, as described."

70. For an *Improvement in Plotting Scales;* Lemuel H. Parsons, Lambertville, New Jersey, September 30.

Claim.—"What I claim to be my invention is, not the division into equal parts, with or without subdivisions of one or more of those parts of the continuous edge of a scale or rule; nor the use of a vernier for measuring or describing right lines, nor the manner of attaching the vernier slide to the main plate of the instrument, nor the use of a lever, or slow motion screw, for adjusting the motions of the vernier slide; but the combined application, in one and the same instrument, of the graduation upon the edge, (to obviate the imperfection and inconvenience attending the use of dividers or compasses,) and the slide carrying with it the several primary divisions of the unit, and those divisions carrying with them respectively, by means of the vernier, the several secondary divisions into hundredths, or otherwise, so as to enable the operator to distinguish and apply hundredths or half hundredths of the smallest unit, with a great rapidity, precision, and ease, as tenths of the same unit, with the scale graduated on the edge, without a slide, and so, likewise, that whatever parts of a unit are required, or whatever the whole length of line to be measured, the whole amount of motion required, in lengthening or shortening the instrument, is only equal to the number of additional or intermediate hundredths, or other subdivisions, never exceeding one-tenth of the unit of measure."

71. For an *Improvement in Fountain Pens;* Newell A. Prince, New Gloucester, Maine, September, 30.

Claim.—"What I claim as my invention is, the improvement of the hollow, flexible and long extension of the reservoir or tube, to extend up and be secured to the arm of the writer, substantially in manner and for the purpose as specified."

72. For an *Improvement in Machines for Sawing Volutes;* Elijah Whiten, Hingham, Massachusetts, September 30.

"The nature of my invention consists in giving the block to be sawed, by a novel mechanical arrangement, two motions, rotary and rectilinear, whereby the block is fed up to the saw, in such a manner as to be, when sawed, a single spiral sheet, or scrowl of wood, or in concentric layers or sheets."

Claim.—"I do not claim the carriage, for carriages have been and are now applied to saw-mills; but what I do claim as new is, 1st, The manner in which I produce the two motions necessary to be given to the block, in order that it may be sawed in the required form, viz: the screw rod with its right and left screws cut upon it, mashing into the pinions, by which motion is communicated to the horizontal rods, the toothed wheels, pinions, or spurs grasping the edge of the block, and causing it to rotate, in combination with the bevel pinions, screw rods, and arm, by which a rectilinear motion towards the saw is given the carriage and block, producing the result described."

73. For an *Improvement in Mitre Boxes;* Matthew Spear, Bowdoinham, Maine, September 30.

Claim.—"What I claim is, one or two rotary saw guides, with sliding gauge rests, and mechanism for rotating the guides, and fixing them in any desirable position or positions, as specified, in combination with the improvement of making or applying the uprights or vertical posts of the saw to the bars, so as to be capable of being turned down to an angle with the horizon, for the purpose as described."

74. For an *Improvement in Shields for Valves;* Alexander Jimason, Parkesburgh, Pennsylvania, September 30.

"This improvement consists in furnishing the valve with a shield, to protect it from the action and reaction of the fluid which surrounds it, when in operation, thus preventing, in a great measure, the rapid destruction of the valves, valve-seats, and chambers, in which the valve is generally made to work."

Claim.—"What I claim is, surrounding the valve by a shield, constructed substantially in the manner as herein described and set forth, and fitting closely enough to regulate the ingress and egress of the water or steam, to such a degree as to prevent the slamming of the valve, in opening and closing."

75. For an *Improvement in the Manufacture of Clay Pipes;* Joseph Putnam, Salem, Massachusetts, September 30.

"My improvements are made upon an apparatus for the same or a similar purpose, for which letters patent were granted to me, dated January seventeenth, in the year of our Lord one thousand eight hundred and twenty-seven, and recorded anew in the Patent Office, on the twelfth day of February, in the year of Lord one thousand eight hundred and thirty-eight, to which patent reference should be had, and are represented in the figures of the accompanying plate of drawings."

Claim.—"Having thus described my improvements in apparatus for moulding clay pipes, I shall state my claim as follows: What I claim is, the use ot the wire gauge frame, constructed substantially as above described, in moulding clay or earthen pipes, in the manner and for the purpose above specified.

"I also claim the improvement above specified, in the sack, in which said pipes are suspended to be dried; said improvement consisting in confining said sack to two rails, kept parallel by means of cross bars, forming with them a rectangular frame, as herein above described."

Designs for September, 1851.

1. For a *Design for Stove Plates;* Calvin Fulton, Rochester, New York, September 2.

Claim.—"What I claim as my invention is, the ornamental design of a stove plate, substantially as herein described and represented."

2. For a *Design for Cast-Iron Bedsteads;* Pellatiah M. Hutton, Troy, New York, September 2.

Claim.—"What I claim as my invention is, the designs and ornaments upon the parts A, B, C, and D, combined as in the drawing hereunto annexed, as applied to iron bedsteads."

3. For a *Design for Stoves;* Anthony W. Jones, City of New York, Assignor to James McGregor, Jr., September 2.

Claim.—"I claim as my invention or production, the above described and illustrated design for the several plates of a stove, as fully set forth; that is to say, I claim the design on each of the plates separately, and on all the plates in combination."

4. For a *Design for Stoves;* Samuel H. Tailor, Kensington, Pennsylvania, Assignor to North, Harrison & Chase, Philadelphia, Pennsylvania, September 2.

Claim.—"What I claim as my invention is, the ornamental design for a stove, as herein described, and as represented in the annexed drawings."

5. For a *Design for Stoves;* Silas Merchant, Cleveland, Ohio, September 2.

Claim.—"I disclaim the hearth *w*, in fig. 1, and the projection L, in fig. 2; but what I do claim as my design and production is, the basso-relievo ornaments, form, and configuration of the doors, E, F, and G, in fig. 1, which are substantially the same as before described in the doors, fig. 2, fig. 3, and fig. 4."

6. For a *Design for Floor Oil Cloths;* James Hutchinson, Troy, New York, Assignor to Deborah, Albert E., and Nathaniel B. Powers, Lansingburgh, Pennsylvania, September 2.

Claim.—"What is claimed as my invention is, the arrangement of figures forming a design for floor oil cloths, as shown in the aforesaid drawing."

7. For a *Design for Shovel Stands;* Charles Zeuner, Assignor to M. Greenwood & Co., Cincinnati, Ohio, September 9.

Claim.—"What I claim as my invention is, the design and configuration of the stand as a whole, as fully shown and represented in the drawing at fig. 1. I claim also the particular ornamenting of the shell or dish used as a base, and the configuration and ornamenting of the standard or upright, and the design of the hooks and the handle, as fully shown and represented in the drawings at figures 1, 2, and 3, and herein before fully set forth."

8. For a *Design for Metallic Gates;* Ebenezer Weeman, Charlestown, Massachusetts, September 16.

Claim.—"I do not claim the design for the posts or pillars in this gate-way, but only the form of the gate suspended between the posts; and I claim the design for gates of this pattern of whatever size they may be made, and of whatever metal they may be cast, and for whatever purposes they may be used."

9. For a *Design for a Ventilating Stove or Furnace;* Elijah P. Penniman, Rochester, New York, Assignor to Henry Brittan, Cobourg, Canada, September 16.

Claim.—"What I claim as my production is, the design, marked fig. 1 and fig. 2."

10. For a *Design for Tables;* Nathan Chapin, Syracuse, New York, September 30.

Claim.—"What I claim as my invention is, the design and configuration of table pillars in the form of vines, supporting by their branches the drawer and upper part of the table with flaming scroll ballustrade pillars, supporting a rim which encircles the main pillars, together with the configuration of an ornamental open work drawer and capital exposed to view on all sides; the whole combining various styles of architecture, as herein before described.

11. For a *Design for Stove Fronts;* Ezra Ripley, Troy, New York, September 30.

Claim.—"What I claim is, the design and configuration of parlor stove fronts, substantially the same as described and represented."

OCTOBER.

1. For an *Improvement in Machines for Opening and Cleaning Flocks;* Ephraim C. Brett, Great Barrington, Massachusetts, October 7.

"The nature of my invention consists in the employment of a circular and a concave grater, between which the flocks is passed and separated, and thence passes into a fan chamber, and is blown out through a conducting spout, whilst the dirt settles and separates therefrom."

Claim.—"What I claim as new is, the arrangement and combination of the conical revolving grater within the close grater case, combined with the blowers, in the manner and for the purpose substantially the same as described and represented."

2. For *Improvements in Apparatus for Applying Flocks to Cloth;* Daniel Pratt and Ransom Pratt, Elmira, New York, October 7.

"The nature of our invention consists in passing the cloth underneath a revolving screen, said screen containing the flock, which is prevented from being packed and kept in a tight state by means of a beater within the screen; the flock falls through the screen upon the cloth, which passes between the corrugated rollers, said rollers working the flock, in a measure, into the texture of the cloth, and preparing it for the operation of fulling."

Claim.—"What we claim as new is, the revolving screen, having a beater within it on a shaft as described, in combination with the corrugated rollers, constructed and operating in the manner and for the purpose substantially as set forth."

3. For an *Improvement in Tanning;* Nathaniel C. Towle, Washington, D. C., October 7.

Claim.—"What I claim as my invention or discovery as a new and useful improvement is, the use of arsenic or arseneous acid, substantially in the manner and for the purposes herein set forth. The peculiar properties of arsenic, by which it tends to suspend the natural tendency of the animal fibre to decomposition upon the extinction of animal life, are well known, and of course they are not patentable; but their application to the processes of tanning, and otherwise preparing skins and hides for useful purposes, by which they are rendered stronger and more durable, is believed not to have been heretofore known and used.

"I do not, therefore, intend to limit my claim to any particular mode or period of using the article; but I shall apply it in such form or in such strength of solution as the nature of the case may require, to effect the objects named. Workmen should guard against the absorption of the poisonous qualities of the arsenic, while immersing or handling the skins in the liquor, by using tools or wearing india rubber gloves. After the skins are taken out of the liquor, and rinsed thoroughly, the danger ceases."

4. For *Improvements in the Endless Chain Propeller;* Charles F. Fisher, New Orleans, Louisiana, October 7.

Claim.—"I do not mean to claim the invention of the endless chain propeller, or the application of the endless chains to communicate power from one wheel to another; but what I do claim as new is, suspending the endless chain propeller, which is to be put in motion by an endless chain running on the side wheel on the principal drum under water, in a rigid frame, inside of the water-tight chamber, the frame being capable of an upward and downward motion, parallel to itself, by means of the four racks and pinions, or their equivalents, acted upon by gearing connected each to each; said frame being connected with an indicator, by which the situation of the propeller may be ascertained; the whole constructed substantially in the manner and for the purposes herein described.

"2d, I claim the sliding lid to the aperture in the bottom of the vessel, through which the propeller projects when lowered for operation; but when the propeller is raised inside of the vessel, the lid closes the aperture, so that the speed of the vessel may not be impeded, when under sail alone, by the action of the water on the aperture in the bottom; said sliding lid being worked by a screw, or its equivalent, in connexion with an indicator, by which the position of the lid can be seen, substantially as herein described."

5. For an *Improvement in Devices for Sowing in a Seed Planter;* W. P. Clements, Ellerslie, Georgia, October 7.

"The nature of my invention consists in the novel manner of availing of the natural motion of the shoulders of a horse or other animal, while walking and propelling a drill, to operate the seed dischargers, so that at each step of the animal its shoulder blades shall act alternately upon levers, reciprocating the arms, working inside the hopper, so as to discharge the desired quantity of seed, without the aid of wheels, cams, or any other machinery than the simple arrangement represented in the drawings, which is not more complicated or more liable to get out of order than an ordinary plough."

Claim.—"What I claim as new is, the novel manner of discharging the seed by the natural motion of the horse or animal, while in the act of walking and propelling the drill, without the aid of wheels, with the arrangement of levers, arms, &c., for discharging the seed, or their equivalents, operating in the manner and for the purpose herein fully set forth and represented."

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6. For an *Improvement in Escapements for Time Pieces;* James Fulton, Louisville, Kentucky, October 7.

Claim.—"What I claim is, the combination of the pallets and lever or levers here set forth, with the above described mode of communicating impulse to the balance in time pieces which keep time by means of a balance."

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7. For an *Improvement in Running Gear of Locomotives;* James H. Murrill, Manchester, Virginia, October 7.

"The nature of my improvement consists in arranging a pair of large unflanched driving wheels at the frontward end of the locomotive, between the ordinary flanched truck wheels, in such a manner as to support the frontward portion of the locomotive engine, heretofore supported by the truck wheels."

Claim.—"What I claim as my invention is, the manner of employing the unflanched driving wheels, connected and arranged as described, with the flanched truck wheels, at the forward end of the engine, in combination with the flanched driving wheels, for the purpose of increasing the traction or adhesion of the driving wheels to the rails, for overcoming steep grades without increasing the weight of the engine."

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8. For *Improvements in Revolving Boilers;* William Scott, Rising Sun, Indiana, October 7.

"The object of my invention is to construct a boiler that shall, with a facility for the rapid generation of steam, combine great economy, both in the size and consequent expense of the apparatus, and in the amount of water requisite, and avoidance of the danger of explosion by unduly heated plates. My improvements have more especial reference to boilers which rotate upon a central shaft or axis."

Claim.—"What I claim as new is, the combination of the small cylinders, provided with apertures and rims as described, with the distributing chamber; the whole revolving around a common axis, and operating substantially as described."

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9. For an *Improvement in Revolving Breech Pistols;* Joshua Stephens, Chicopee, Massachusetts, Assignor to the Massachusetts Arms Company of Chicopee Falls, October 7.

Claim.—"I do not claim to make the latch hook alone revolve on the barrel; but I claim the improvement of so connecting or combining the latch hook, the slide bearing of the rammer, and the lever, with the barrel. by means of the swivel tube, or any analogous contrivance, as to enable them to be all simultaneously turned laterally, or revolved around the axis of the barrel, and thereby remove any obstruction to the elevation or upward movement of the barrel, such as may be necessary in order to effect the removal of the cylinder of charging chambers, from the arbor on which it is supported."

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10. For an *Improvement in Apparatus for Warming Air and Water for Dwellings;* Le Grand C. St. John, Buffalo, New York, October 7.

"The nature of my invention consists in making a fire-proof apartment, with either circular or rectangular sides, from the lowest extremity of the house to the roof. At the bottom of this apartment are furnaces, the heat of which enters the apartment. The pipes of stoves enter the same apartment, and wind around its sides to a chimney near the roof. In cold weather the heat is taken from this apartment in pipes to warm the house, and in warm weather it is turned out of the house, through the chimney. Any requisite degree of heat may be made without waste of fuel. If the fire from the cooking stove, which passes through the pipe, does not warm the house sufficiently, the heat of one or more furnaces may be added. The top of the apartment has a bowl in the roof, from which the water may pass down in a pipe in the apartment to a reservoir, or pass into a structure, filling cisterns opposite the different stories, and the surplus then pass, by pipes, into a reservoir, from whence it may be re-elevated for the supply of upper rooms."

Claim.—"What I claim as my invention is, the construction of a fire-proof apartment in houses, extending from the lowest extremity of the house to the roof, with furnaces at the bottom; the smoke pipes of other fires, entering it, and winding along its walls to a chimney at the top, and with openings to let the heat in the apartment into the house, or up the chimney; and also for the construction of cisterns within the fire-proof apartment, with the pipes, as above described."

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11. For an *Improvement in Machines for Cutting Screws on Posts and Rails of Bedsteads;* Orion Thornley, Lebanon, Indiana, October 7.

"The principal feature of this invention consists of such an arrangement of mechanism as to cut accurately the screw threads upon both ends of a beam of a right and left screw bedstead, and at the same time, and by the same operation, cut the inverse thread of the sockets of two posts, which are to receive the two screw tenons of the said rail."

Claim.—"What I claim as my invention is, the trifurcated travelers, in combination with the right and left screw axle, the carriage, saddles, hollow axle, and cutters, whereby the threads of two beam tenons and two sockets are cut by one and the same operation; the several devices being constructed and arranged in the manner and for the purposes herein set forth."

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12. For an *Improvement in Portable Elevated Ovens;* Patrick Killin, Mount Healthy, Ohio, October 7.

"My oven is composed essentially of two compartments, the one above the other; in the upper, the articles to be cooked are placed; the lower acts as a receiver, into which the gases are conducted after they have given off a portion of their heat in their passage through radiating flues, projecting upwards into the body of the baking compartment, and from which they are discharged; the gases and flame in passing from the receiver through the ascending pipe, are conducted directly against the bottom of a boiler placed on the pot hole, in the top of the stove, after which they are conducted by the descending flue to the chimney. The whole constitutes a convenient portable auxiliary stove, which can be heated by the ordinary earthen or iron furnaces in common use."

Claim.—"What I claim as my invention is, the arrangement as herein described, of the inner and outer concentric tubes with respect to the oven and pot hole as described, whereby the oven is equally heated by a small fire, and the heat is directed by the inner upright pipe against the bottom of the kettle or other vessel, thus enabling the user to conduct, simultaneously, the several operations of baking and boiling with a small fire, and with economy of fuel."

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13. For an *Improvement in Machines for Cutting Screws on Rails of Bedsteads;* Spencer Lewis, Rochester, New York, October 7.

"The nature of my invention consists in constructing a hand implement for cutting right and left handed screws on tenons of bedstead rails; said implement consisting of a reversible cylinder, provided at either end, on the opposing sides thereof, with a V shaped cutter, each combined in a peculiar manner. Also, in having locking and unlocking screw shanks made to slide horizontally in the ends of arms which embrace the end of the rail, and securely hold the implement thereto, during the operation of cutting the right and left screw; and likewise, in having a central screw shaft, projecting from the cross-head of the reversible cylinder, (to the end of which the power to rotate said cylinder is applied,) surrounded by a hollow shaft, provided with an inverse and male screw thread, and enclosing the latter with a cylindrical or other shaped case, having an inverse screw thread, matching with the male screw thread of the hollow screw shaft; the whole composing a self-reversing, self-locking and unlocking implement for cutting the right and left screw, by an alternate reverse rotation and position of the cylinder; the implement being adaptable to both ends of the rail alike."

Claim.—"What I claim as my invention is, 1st, in combination with the central screw shaft D, through which the rotation of the cylinder A is effected, the hollow screw shaft E, provided with an inverse and male screw thread, and cylindrical case F, having an inverse screw thread matching with the male screw thread of the hollow shaft E; the whole being arranged as above set forth, and operated by means of the bolts, *c* and *b*, and cam H, on the cross-head, in such a manner as to feed the cylinder A, frontward, simultaneously with a right or leftward rotation thereof, as fully described and shown in the drawings.

"2d, I also claim the employment of the screw shanks, J, J, provided with toothed wheels, K, K, made to match with toothed or ribbed plates L, L, forming one of the sides of each box, the outer ends of said screw shanks J, J, being confined in inverse screws, formed in plates *d*, *d*, whilst their inner or pointed ends are supported by plates *k*, *k*, having projections k^2, k^2, against which the shoulder of the rail acts, for the purpose of actuating said screw shanks rotarily, for imparting thereto a lateral movement in such a manner as to cause their pointed ends to enter the rail, and be locked thereto by the spring levers M, said screw shanks J, being detached from the rail when unlocked, by simply withdrawing the implement therefrom, as fully described and shown in figs. 2 and 3.

"3d, I further claim the employment of the semi-circular plate O, of the cross-head C, in combination with the spring levers M, M, for the purpose of actuating said spring levers M, in locking and unlocking the plates *k*, *k*, of the screw shanks, J, J, at the terminus of the receding movement of the cylinder A, whether cutting the right or left screw, as described and represented.

"4th, I also claim confining each V shaped cutter P, to the reversible cylinder A, by means of the segmental brace plate R, notched at one end, so as to interlock with the end of the shank of the cutter projecting through an opening S^3 in the cylinder, whilst its opposite end is made to fit against the frontward portion of the cutter at S^2, said segmental brace plate R, being secured by means of a screw bolt S, passing through it and the cylinder, and pressing upon the shank of the cutter P, in such a manner as to form a complete lock thereto; there being a binding pressure at four points upon the cutter, viz: at either extremity thereof, at the connexion of the brace plate R, with the frontward end of the cutter, and the centre by the confining screw bolt S, thus rendering it impossible to move the cutter without fracturing the segmental brace plate R, and displacing the screw bolts S, as described and represented."

14. For an *Improvement in Locomotives Moved by the Power of Animals;* Clement Masserano, Turin, Sardinia, Assignor to Clement Masserano, Josephine Wickliffe, Administratrix of R. Wickliffe, Jr., Lexington, Kentucky, Charles Carinzi, Andre Crestadora, Pellegro Rocca, and Louis B. Migone, Genoa, Sardinia, October 7.

"The object of my invention is, to apply the force exerted by animals to the transportation of passengers and merchandize, with greater economy than has hitherto been obtained, and at the same time to render the attainment of a high velocity practicable, without urging the animals employed beyond the speed at which they can work to the best advantage, and without forcing them to work in disadvantageous positions. The first of these objects is effected by constructing the mechanism employed, in such manner that the friction of the moving parts is reduced to the lowest limit attainable, without uselessly increasing the complexity and weight of the mechanism; and the second object is attained by mounting the animals upon the car or other vehicle to be moved, in such manner that the animals can work in their best positions, and to the best advantage, whether the plane in which the vehicle moved be horizontal or inclined; my improvements are applicable to every species of locomotion, whether on land or in water."

Claim.—"What I claim as new is, 1st, the combination with the endless platform, of an adjusting apparatus, by means of which the inclination of the platform to the frame of the power carriage may be varied, to enable the horses to work to the best advantage, whether to accelerate or to retard the movement of the impulsoria, in traversing ascending or descending grades.

"2d, I also claim the method of connecting the frame of the impulsoria with the pilot, by means of a longitudinal shaft, which is fitted with mechanism, by means of which the impulsoria can be adjusted transversely, to keep the driving axle level, and to prevent the endless platform from sloping cross-wise, when traversing a road one of whose sides is higher than the other.

"And lastly, I claim in an apparatus adapted to propulsion by animals, substantially as herein described, the employment of a single driving wheel, arranged in such manner as to admit of being leaned towards the hill in traveling across slopes, to prevent a transverse sloping of the endless platform on which the animals walk, when the wheel thus arranged is steadied by a pilot before, and a follower behind, or their equivalent, substantially as herein set forth."

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15. For an *Improvement in Circuit Changers for Electro-Magnetic Telegraphs;* Chas. S. Bulkley, Macon, Georgia, September 2.

"In order to transmit intelligence by telegraph, for very long distances, it has been found necessary to have what are called "relay circuits;" the vibrations of making and breaking the circuits in writing being communicated from one to the other, by "receiving magnets." But by these means the writing can only be done in one direction, unless a re-arrangement is made in the connexions, which can only be done by the operators at the intermediate stations, and consequently, if they wish to write back, or if an error takes place, or any other difficulty occurs, the writer cannot be notified of it, without considerable difficulty. My invention is designed to obviate these defects, and to put it in the power of the operators at either end of the line to arrange the circuits at the intermediate or relay stations, suitably for them to transmit the message, and the operator at the opposte end having the power to interrupt and write back at pleasure; and besides, in the event of any of the circuits breaking, the operator is immediately aware of it, by his own instrument ceasing to operate."

Claim.—"What I claim as new is, the "circuit changer," substantially as above described, in combination with the arrangement of wires, magnets, &c., as set forth, for the purpose of enabling the operator at either one of two distant stations to arrange the connexions at the intermediate stations, so that he can write through to the other end station at pleasure."

MECHANICS, PHYSICS, AND CHEMISTRY.

For the Journal of the Franklin Institute.

A few Suggestions as to the Manner of Laying Out a Propeller, when the Dimensions of the Vessel are given. By J. W. NYSTROM.

When a propeller vessel is to be built, we first have the dimensions of *tonnage*, *length*, and *beam*. From them the ship-builder lays out the lines of the vessel, and ascertains the tonnage, greatest transverse section, area of the displacement, draft of water, &c. From these the propeller is to be constructed, and suppose the following to be the dimensions, viz:

Length on Deck, ...	230 feet.
Beam, ...	35 "
Draft of Water from bottom of keel, . .	15·5 "
Greatest transverse sectional area of displacement, .	500 sq. ft.
Displacement, ...	1770 tons.

Diameter of Propeller.—The diameter depends on the draft of water, and in this instance can be made 14 feet, when the draft of water is 15·5.

Pitch.—The pitch of a propeller depends on the arrangement of the steam engine, as if it is with gearing or direct action.

Let the number of revolutions of the propeller be n, when the number of revolutions of the steam engine is n', a proper pitch will be

$$P = 2{\cdot}5\,D\sqrt{\frac{n'}{n}}, \quad . \quad . \quad . \quad . \qquad (1.)$$

in which D denotes the diameter of the propeller in feet, and P the pitch, also in feet.

If the propeller is to be centripetal, the pitch can, without detriment, be taken larger than with straight-bladed propellers, and in this instance we will construct the propeller for a direct action steam engine, and take the pitch

$$P = 2\tfrac{5}{8}\,D = 2{\cdot}625 \times 14 = 36{\cdot}75 \text{ feet.}$$

Slip.—The slip depends on the displacement, and greatest sectional area of displacement, when the propellers have equal pitch in proportion to the diameter.

$$S = \frac{\otimes^2 + \sqrt[3]{Q^2}}{10\,A}, \quad . \quad . \quad . \quad . \qquad (2.)$$

or

$$S = \frac{500 + \sqrt[3]{1770^2}}{1540} = \frac{646}{1540} = 0{\cdot}42 \text{ per ct.*}$$

$\otimes^2 = 500$ square feet, greatest sectional area.
$Q = 1770$ tons displacement.
$A = 154$ square feet, or $0{\cdot}785\,d^2$.

Propellers with less pitch in proportion to the diameter will give less slip, but in those instances the slip is not a measure of loss of effect or quality of propellers. The slip is nearly constant with different velocities until a certain limit; when it exceeds that, the slip will increase by the excess of velocity.

Velocity of the Propeller.—The velocity of propellers depends on the *pitch*, *diameter*, and *slip*, and can by them be proportioned to suit the steam engine. The proper velocity or number of revolutions per minute n, in order to give the vessel the highest speed with the greatest economy of fuel, is

$$n = \frac{200}{S\,P}\sqrt{D}. \quad . \quad . \quad . \quad . \qquad (3.)$$

$$n = \frac{200}{0{\cdot}42 \times 36{\cdot}75}\sqrt{14} = \frac{200 \times 3{\cdot}74}{0{\cdot}42 \times 36{\cdot}75} = 48{\cdot}5 \text{ revolutions.}$$

From this number of revolutions, pitch, slip, and diameter, the *power* of the steam engine is to be ascertained; but, before entering into that, we will finish the propeller. The propeller to be centripetal; (see Vol. XXI., 3d series, page 345,) we have the angle w° as follows:

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[*] Perhaps it will be deemed that 42 per cent. slip is too much compared with the common announcement of slip; but in a calculation like this the *fact* must be followed. We often hear, and sometimes see, the slip *on paper* to be 10 or 20 per cent., which does not always correspond with the slip *in the water.*

$$\text{Fig. 1.}\ \begin{cases} {}^{\circ}w = \dfrac{D\,n^2\,S^2}{200}, & \ldots\ldots\ldots\quad (4.) \\ {}^{\circ}w = \dfrac{14\times 48{\cdot}5^2\times 0{\cdot}42^2}{200} = 29^{\circ}. & \end{cases}$$

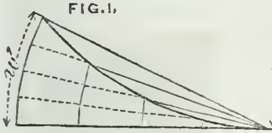


FIG. 1.

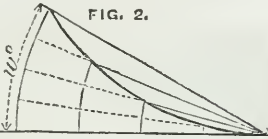


FIG. 2.

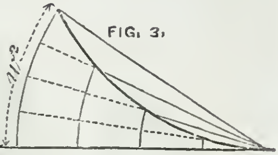


FIG. 3.

Compute two more angles, ${}^{1}w$ and ${}^{2}w$, from the following formulæ:

$$\text{Fig. 2.}\ \begin{cases} {}^{1}w = \dfrac{{}^{\circ}w}{2}\,(2-S). & \ldots\ldots\ldots\quad (5.) \\ {}^{1}w = \dfrac{29}{2}\,(2-0{\cdot}42) = \dfrac{29\times 1{\cdot}58}{2} = 22{\cdot}91^{\circ} = 22^{\circ}\ 55'. & \end{cases}$$

This is to be the first edge of the propeller, and the following the after edge:

$$\text{Fig. 3.}\ \begin{cases} {}^{2}w = \dfrac{{}^{\circ}w}{2}\,(2+S). & \ldots\ldots\ldots\quad (6.) \\ {}^{2}w = \dfrac{29}{2}\,(2+0{\cdot}42) = \dfrac{29\times 2{\cdot}42}{2} = 35{\cdot}09 = 35^{\circ}\ 5'\ 20''. & \end{cases}$$

In each of these angles, ${}^{\circ}w$, ${}^{1}w$, ${}^{2}w$, construct a curved line, as in fig. 1, 2, and 3; place them on a common axis, fig. 4, so that the planes on which the curved lines are drawn shall be at right angles to the axis, and a distance between the two curved lines ${}^{1}w$ and ${}^{2}w$ equal to the length l of the propeller. See fig. 5 and 8.

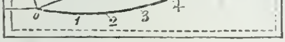


FIG. 4.

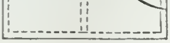


FIG. 5.

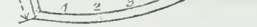


FIG. 6.

Number of Blades.—The number of blades in a propeller depends on the *slip*, and the angle V, fig. 8. The more slip, and the larger the angle V, the less the number of blades should be. As to the number of blades in a propeller, it is known from experiment, that a less number do better or just as well as a greater; it may be so under some circumstances, but is not always. In canal and tow boats, where the slip is considerable, a two or three-bladed propeller will no doubt do the best execution, but for vessels which are to run fast, and the propeller to have a slight slip, a six-bladed propeller should give the greatest effect; but in such cases the propeller must be particularly constructed, and the length l, fig. 5

and 8, be only one-quarter ($\frac{1}{4}$) of the diameter. If this is disproportioned, and the blades are wrong, of course there ought to be a less number of them; but whatever the number of blades may be, take the length l from the following formula (7). The number of blades is denoted by the letter m, and in the propeller we are constructing we will take five (5) blades.

FIG. 7.

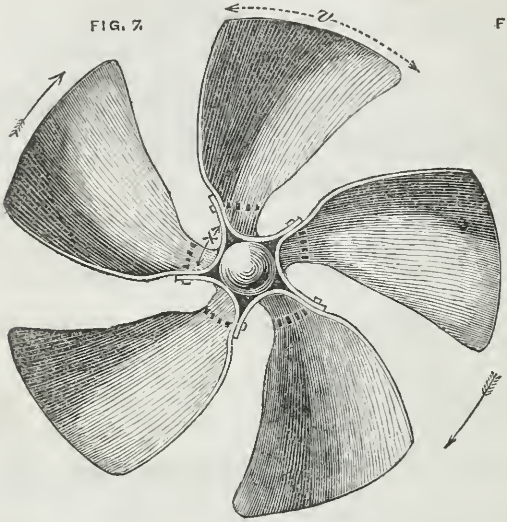


FIG. 8.

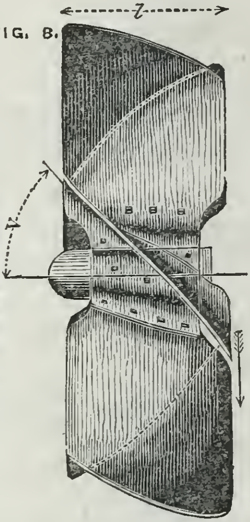


Fig. 5 & 8.

$$L=\frac{0{\cdot}6\,P}{m}. \qquad (7.)$$

$$L=\frac{0{\cdot}6\times36{\cdot}75}{5}=4{\cdot}2 \text{ feet.}$$

Or say 4·5 feet, which will be the distance between the two curved lines ${}^1w$ and ${}^2w$, fig. 4 and 5, on the axis. Place the plane of the curved line ${}^\circ w$ in the middle between the planes of the curved lines ${}^1w$ and ${}^2w$; draw straight lines from the centre to the extremity of the curves; place the curved lines ${}^1w$ and ${}^2w$ so that the angle V will be as follows:

Fig. 4.

$$V=\frac{360\,L}{P}. \qquad (8.)$$

$$V=\frac{360\times4{\cdot}5}{36{\cdot}75}=44{\cdot}2=34^\circ-12'.$$

Place the curved line ${}^\circ w$ between the curves ${}^1w$ and ${}^2w$, so that the angle ${}^1V$ will be

Fig. 4.

$${}^1V=\frac{V}{4}(2+S). \qquad (9.)$$

$${}^1V=\frac{44{\cdot}2}{4}(2+S)=\frac{44{\cdot}2\times2{\cdot}42}{4}=26{\cdot}74^\circ=26^\circ\,44'\,30''.$$

When the curves are laid down in these positions, make a drawing of the propeller, as fig. 7 and 8, which represents a propeller made of wrought iron. If made of cast iron, these curved lines $^{\circ}w$, ^{1}w, and ^{2}w lay out in loom. Build to the curves a box, fig. 4 and 5; form it in the hub after the drawing, so that x is equal to x. In this box build a pattern of boards, about 2½ by 3 inches. The boards are to run from the curve ^{1}w to the curve ^{2}w, so that the edges or seams may run parallel with the same figures on the curves, and form a regular curve, for instance an arc of a circle, touching the curve $^{\circ}w$. When the slip exceeds 50 per cent. it will be necessary to pay more attention to this curve, and lay out five w curves instead of three. From this pattern cast a block of cast iron, represented in fig. 6; bore holes in this block, corresponding to the holes for the screws by which the propeller blades are screwed together. Fit a pasteboard on the face side of the block, and make it the same shape as the propeller blades are to be; when fitted precisely, mark the holes on the pasteboard; from this cut out one propeller blade from the sheet iron, and bore the holes accurately from the pasteboard. From this blade cut out the rest of the propeller blades, and one more than the number of blades in the propeller. Afterwards bend these blades over the block, (fig. 6,) so that the holes correspond with each other; then the blades are ready to screw together. If the holes are not bored before the blades are bent, they must be marked on the block, (fig. 6,) if not the blades will never come in their proper position, and it will cause much trouble in putting them together.

The hub can be cast in the propeller after the blades are screwed together, or it can be cast separately as a round cylinder.

Now the speed of the vessel can be calculated, and will be in miles per hour,

$$M = \frac{60\,n\,P(1-S)}{5280}. \qquad \ldots\ldots \qquad (10.)$$

$$M = \frac{36{\cdot}75 \times 0{\cdot}58 \times 48{\cdot}5 \times 60}{5280} = 11{\cdot}75 \text{ miles per hour.}$$

The distance from Liverpool to New York being 3100 miles, the vessel will run that in a time of $\frac{3100}{24 \times 11{\cdot}75} = 11$ days. To Boston, in 10 days 7¼ hours. To Halifax, in 8 days 21½ hours.

The effect of a steam engine, sufficient to drive the propeller 48·5 revolutions per minute, will be found by the following formula, in horse power:

$$H = \frac{n^2 A}{1950} \sqrt{P S}. \qquad \ldots\ldots \qquad (11.)$$

$$H = \frac{154 \times 48{\cdot}5^2}{1950} \sqrt{36{\cdot}75 \times 0{\cdot}42} = 735 \text{ horses.}$$

To be two direct action condensing engines. Let us determine the effectual pressure per square inch to be 25 pounds, say pressure in the boiler to be 20 pounds, cutting off at ⅓ stroke; the mean pressure will be 14 pounds, vacuum 11 pounds, effectual pressure, p, $=25$ pounds.

The area of the cylinder piston, in square inches, will be found by the following formula:

$$a=\frac{4{\cdot}24\,n\,A\,\sqrt{PS}}{p\,s\,(1-f)}. \quad . \quad . \quad . \quad . \quad . \qquad (12.)$$

In which s denotes the stroke of the piston in feet, and f = friction, working pumps, and per cent., which, in this intended steam engine, will be $f=0{\cdot}32$ per cent. Let the proportions of stroke and diameter of the piston be as 2 to 3, we have the diameter in inches:

$$d=\sqrt[3]{\frac{94\,n\,A\,\sqrt{PS}}{p\,(1-f)}}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \qquad (13.)$$

$$d=\sqrt[3]{\frac{94\times 48{\cdot}5\times 154\sqrt{36{\cdot}75\times 0.42}}{25\times(1-0{\cdot}32)}}=54{\cdot}7 \text{ inches.}$$

Say 56 inches diameter and 36 inches stroke, the effect of the steam engine, in horse power:

$$H=\frac{a\,p\,s\,n}{33000}\,{\cdot}4\,(1-f). \quad . \quad . \quad . \quad . \quad . \quad . \qquad (14.)$$

$$H=\frac{2463\times 25\times 3\times 48{\cdot}5}{33000}\,{\cdot}4\,(1-0{\cdot}32)=740 \text{ horses.}$$

Cut off the steam at one-third of the stroke, c being the cubic feet of steam for each revolution, and k denotes the volume of steam compared with water at the given pressure.

$$c=\frac{56^2\times 0{\cdot}785\times 12\times 4}{1728}=68{\cdot}4;\ \text{say 70 cubic feet.}$$

The consumption of coal, if anthracite, will be:

$$\text{Coal}=\frac{c\,n}{x\,k}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \qquad (15.)$$

$$\text{Coal}=\frac{70\times 48{\cdot}5}{4{\cdot}8\times 770}=0{\cdot}918 \text{ tons per hour.}$$

That is when one pound of anthracite coal evaporates 8 pounds of water per hour; or call the number of pounds of water $=w$, evaporated per pound of coal, we have for x,

x	:	w
3·5	:	6
4·18	:	7
4·45	:	7·5
4·77	:	8
5·08	:	8·5
5·35	:	9
5·67	:	9·5
6	:	10

Plate XIII. represents a section of a vessel, of the aforesaid dimensions. On the bottom lays two inclined, direct action, condensing steam engines.

A, The Engineer's Room.
B, First Class Cabin.
C, Ventilator and Sky-Light.
D, State Rooms.
E, Store Rooms.
F, Passages.
G, House on Deck.
H, Berths.

The engine is manœuvered in the engine room A, by the three rods *a*, *b*, and *c*, which run through the columns in the engineer's room.

The four gauges on each side are the steam gauge, vacuum gauge, water gauge for the boiler, and salinometer; in the front is a clock and counter.

a is for regulating the injection water, connected with the injection cock *k*.

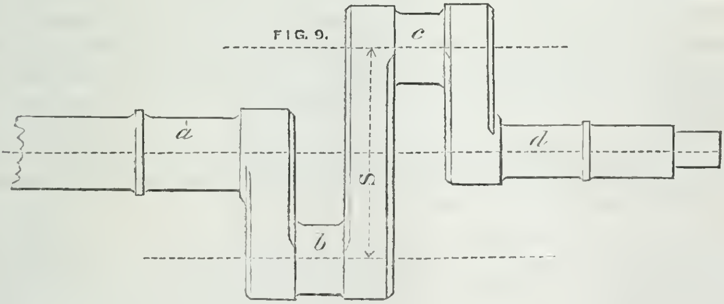
b for reversing the eccentrics, to back and go ahead, connected with a conical cog wheel.

c for regulating the steam to the engine; by the same rod steam can be given to full stroke.

d Cylinder heads.
e Injection water pipe.
f Steam pipe.
g Steam chest.
h Exhaust pipe.
i Discharge pipe.
k Injection cock.
l Condenser.
m Air pumps, double and direct action.
n Feed and Force Pumps, double and direct action.
o Air vessels.
p Eccentrics for the steam valves.
q Frames and guides.
r Steam cylinders.

The engines are working on a double crank, represented in fig. 9. The scale is $\frac{3}{8}$-inch to a foot. The cranks are opposite to each other; therefore the steam engines *do not work at right angles;* but if it is thought more desirable that they should, the cranks can be set in any angle; this is a matter of small consequence compared with the friction in the bearings *a* and *d*, which the opposite cranks prevent, and it is the reason why the stroke of the piston can be taken so short in proportion to the diameter.

FIG. 9.



Now for the *strength* of this crank, which, at first sight, promises little for durability. Let the end *a* be the continuation of the propeller shaft, and the steam engines be applied at *b* and *c*; let the force which is applied at *c* be denoted by the letter *c*. The force which acts to twist the crank at *b* will be *c s*; but as there is a bearing at *d*, the resistance at *b* acts to twist the crank at *c* with a force $= b\,s$; if the crank should break, the force *c* must break it both at *c* and *b* at the same time, which will require twice the power that would break it only at *b*; or $\frac{c\,s}{2}$ will be the force by which the crank should be twisted at *b*, which is exactly the same as the force *c* applied to *b*, to twist the shaft at *a*, or if the diameter at *a*, *b*, and *c* be equal, the strength of the *opposite cranks* will be the same as a common single crank.

Let D be the diameter of the propeller shaft in inches, and of wrought iron.

$$\mathsf{D} = 8{\cdot}15\sqrt{D\,P\,S}. \qquad . \quad . \quad . \quad . \quad . \qquad (16.)$$

$$\mathsf{D} = 8{\cdot}15\sqrt{14 \times 36{\cdot}75 \times 0{\cdot}42} = 12 \text{ inches.}$$

The diameter at *d* will be the same as the diameter for a crank pin of a common single crank; or

$$\delta = \sqrt{\mathsf{D}^2 + 1{\cdot}2s^2} - 1{\cdot}1s. \qquad . \quad . \quad . \qquad (17.)$$

$$\delta = \sqrt{12^2 + 1{\cdot}2 \times 3^2} - 1{\cdot}1 \times 3 = 8{\cdot}5 \text{ inches.}$$

This kind of crank was tried and tested by a Swedish Engineer, O. E. Carlsund, and the results were most satisfactory. The engines were 30 inches in diameter and 18 inches stroke; they made from 105 to 110 revolutions per minute. The air pumps were direct action, working at the same speed with 18 inches stroke; pressure in the boiler, 30 pounds to the square inch, cutting off at one-third of the stroke; the air pumps and valves worked silently.

In direct action propeller engines, the arrangement of the air pumps and their valves, is of the greatest importance. Many engineers are of the opinion that the more vacuum the better. There is, however, an exception with propeller engines, when the engines and air pumps are direct action. As an example, in an experiment made by the same engineer, O. E. Carlsund, he placed a small cock on the condenser; while the steam engine was working with a good vacuum he opened the cock, letting in a little air to the condenser. The number of revolutions increased from 15 to 20 per cent.; the *cause* of it, I leave to engineers for solution.

When an air pump makes more than *n* double strokes per minute, it does not work well, or rather works to a disadvantage. This number *n*, will be found by the formula

$$n = \frac{121\,\mathfrak{a}}{\mathfrak{A}\,\mathfrak{s}}\sqrt{\mathfrak{p}} \qquad . \quad . \quad . \quad . \quad . \quad . \quad . \qquad (18.)$$

in which $\mathfrak{a}$ denotes the area of the valves, and $\mathfrak{A} =$ area of air pump piston; $\mathfrak{s}$ being the stroke of air pump piston in feet. $\mathfrak{p} =$ pressure in the condenser.

When the number of double strokes per minute are given, the area of the valve will be

$$\mathfrak{a}=\frac{n\,\mathfrak{A}\,\mathfrak{s}}{121\sqrt{\mathfrak{p}}} \quad . \quad . \quad . \quad . \quad . \quad . \qquad (19.)$$

When we get from this formula $\mathfrak{a}=\mathfrak{A}$ or $\mathfrak{a}>\mathfrak{A}$ the air pump will work with disadvantage; or when the valve $\mathfrak{a}$ is applied in the air pump piston, we only get $\mathfrak{a}=\frac{3}{8}\mathfrak{A}$ then, $\mathfrak{s}$ and $\mathfrak{p}$ are the only quantities which can be modified, and $\mathfrak{s}$ will be

$$\mathfrak{s}=\frac{121\,\mathfrak{a}}{n\,\mathfrak{A}}\sqrt{\mathfrak{p}.} \quad . \quad . \quad . \quad . \quad . \quad . \qquad (20.)$$

In the steam engine represented on plate XIII. the valves are round and move on vertical spindles. The stroke of the air pump piston is equal to the stroke of the cylinder piston, and the diameter is 14 inches. In that case, the diameter of the valve must be calculated, and will be as follows:

$$\mathfrak{d}=\frac{\mathfrak{D}\sqrt{n\,\mathfrak{s}}}{11\sqrt[4]{\mathfrak{p}.}} \quad . \quad . \quad . \quad . \quad . \qquad (21.)$$

$$\mathfrak{d}=\frac{14\sqrt{48\cdot5\times3}}{11\sqrt[4]{4}}=10\cdot5 \text{ inches.}$$

or, say 11 inches, as the spindle in the centre takes a few square inches. These formulæ, (18, 19, 20, 21,) undergo a little modification with different arrangements of condensers and air pumps, for instance, if the air pumps are vertical or horizontal.

In this steam engine, the air pumps have an inclination of 16 degrees to the horizon.

It is of no consequence what angle the steam engines make with each other but rather make it to suit the bottom of the vessel. There will always be angle enough for one engine to help the other over the centre, and the greater the angle the better for the friction in the bearings. With those kind of steam engines, there is sufficient room in the breadth of any vessel to get the connecting rod twice the stroke. The entire engine comes below the load line, and makes an arrangement with every convenience.

Under full motion, all the parts of the machinery are accessible for the engineer. The weight of the engines, including air pumps and condensers, will be, stationary parts, 22 tons, moving or working parts, 8 tons, total weight, 30 tons; occupying a space in the length of the vessel of only 8 feet 4 inches. Lower hold is 12 feet; on the first deck, 7 feet; on the second deck, 8 feet.

A Table of Equations Collected for Convenience and Reference.

$$P=2{\cdot}5D\sqrt{\frac{{}^1n}{n}}. \qquad 1.$$

$$S=\frac{\otimes^2+\sqrt[3]{Q^2}}{10\,A}. \qquad 2.$$

$$n=\frac{200}{P\,S}\sqrt{D}. \qquad 3.$$

$${}^{\circ}w=\frac{D\,S^2\,n^2}{200}. \qquad 4.$$

$${}^1w=\frac{{}^{\circ}w}{2}\,(2-S). \qquad 5.$$

$${}^2w=\frac{{}^{\circ}w}{2}\,(2+S). \qquad 6.$$

$$L=\frac{0{\cdot}6\,P}{m}. \qquad 7.$$

$$v=\frac{360\,L}{P}. \qquad 8.$$

$${}^1v=\frac{v}{4}\,(2+S). \qquad 9.$$

$$M=\frac{P\,n}{88}\,(1-S). \qquad 10.$$

$$H=\frac{A\,n^2}{1950}\sqrt{P\,S}. \qquad 11.$$

$$a=\frac{4{\cdot}24\,n\,A\,\sqrt{P\,S}}{p\,s\,(1-f)}. \qquad 12.$$

$$d=\sqrt[3]{\frac{94\,n\,A\sqrt{P\,S}}{p\,(1-f)}}. \qquad 13.$$

$$H=\frac{a\,p\,s\,n}{33000}\cdot 4\,(1-f). \qquad 14.$$

$$\text{Coal}=\frac{c\,n}{x\,k}. \qquad 15.$$

$$\mathsf{D}=8{\cdot}15\sqrt{D\,P\,S}. \qquad 16.$$

$$\delta=\sqrt{\mathsf{D}^2+1{\cdot}2\,s^2}-1{\cdot}1s. \qquad 17.$$

$$n=\frac{121\,\mathfrak{a}}{\mathfrak{A}\,\mathfrak{s}}\sqrt{\mathfrak{p}}. \qquad 18.$$

$$\mathfrak{a}=\frac{n\,\mathfrak{A}\,\mathfrak{s}}{121\sqrt{\mathfrak{p}}}. \qquad 19.$$

$$\mathfrak{s}=\frac{121\,\mathfrak{a}}{n\,\mathfrak{A}}\sqrt{\mathfrak{p}}. \qquad 20.$$

$$\mathfrak{d}=\frac{\mathfrak{D}\sqrt{n\,\mathfrak{s}}}{11\sqrt[4]{\mathfrak{p}}}. \qquad 21.$$

$$p=\frac{4{\cdot}24\,n\,A\sqrt{P\,S}}{a\,s\,(1-f)}. \qquad 22.$$

$$n=\frac{a\,p\,s\,(1-f)}{4{\cdot}24\,A\sqrt{P\,S}}. \qquad 23.$$

$$S=1-\frac{88\,M}{P\,n} \qquad 24.$$

$$P=\frac{200}{S\,n}\sqrt{D}. \qquad 25.$$

$$P=\frac{360\,L}{v}. \qquad 26.$$

$$P=\frac{\pi\,D\,L}{e}. \qquad 27.$$

$$P=\frac{\pi\,D\,L}{\sqrt{b^2+L^2}}. \qquad 28.$$

$$P=\cot.\,V\,\pi\,D. \qquad 29.$$

$$\text{Cot. }V=\frac{P}{\pi\,D}. \qquad 30.$$

D = Diameter of the Propeller in feet.
P = Pitch.
L = Length of the Propeller in feet.
A = Area in square feet.
S = Slip in decimal fractions.
m = Number of Blades in the Propeller.
n = Number of Revolutions per minute.
b = Extreme Breadth of the Propeller Blade over its extremity in feet.
e = Length of the Circle Arc in the angle v in feet.
$\otimes^2$ = Transverse Sectional Area of Displacement.
Q = Displacement in tons.
^0w, ^1w, ^2w, v, ^1v, and V = Angles in degrees of a Circle.
M = Statute miles per hour.
H = Actual horse power.
a = Area of the Piston in square inches.
d = Diameter of Cylinders in inches, when there are two direct action Cylinders, and stroke of Piston $d = 1{\cdot}5s$.
p = Effectual Pressure on the Piston per square inch, including the vacuum.
s = Stroke of Piston in feet.
c = Cubic feet of Steam for each revolution.
k = Volume of Steam compared with Water.
x = Coefficient of Water evaporated per pound of coal per hour.
f = Friction and working the Pumps, per cent.
Coal = Anthracite, in tons, per hour.
$\mathfrak{A}$ = Area of the Air Pump Piston.
$\mathfrak{a}$ = Area of the Air Pump Valve.
$\mathfrak{D}$ = Diameter of Air Pump Piston.
$\mathfrak{d}$ = Diameter of Air Pump Valve.
$\mathfrak{s}$ = Stroke of Air Pump Piston.
D = Diameter of Propeller Shaft.
δ = Diameter of Crank Pin.
$\mathfrak{p}$ = Pressure in the Condenser.

Table for Finding the Pitch of Propellers.

By this table (plate XIV.) the pitch of a propeller can be found in an instant, with any diameter and angle of the propeller blades, between 45° and 70°. The degrees will be found on the circular arc; the diagonals show every tenth minute where the pitch arm crosses the same at *a*.

The pitch will be found on the pitch-arm, where the diameter lines cross the same, when set on a given angle at *a*. If the angle is to be found, when the diameter and pitch are given, move the pitch-arm until the given pitch crosses the given diameter line; the corresponding angle will be found at *a*.

Propeller makers not fully acquainted with the theory of the propeller, will sometimes find it difficult to lay out the propeller with a certain pitch, or when a few dimensions are given, to ascertain the pitch; for that purpose there are some tables, which will probably meet with their approbation, for convenience in practical use.

When the centripetal propeller has been fully tested by experiment, it is intended to publish a small work, containing those Tables, and directions relating to propellers in general.

As the screw propeller is the most valuable instrument for the propelling of vessels, and thus far, behind the paddle wheels in the employment of steam for propelling, its friends therefore, ask for the screw propellers and their engines, that they should be submitted to a series of patient and impartial experiments; extending through two or more different vessels, and six or more different propellers. These experiments I feel confident, will result in *proving its equality* to paddle wheels, and as the screw propeller (if rightly made,) is a direct action propelling instrument, as well as the paddle wheels, why should the preeminence be justly on the side of the latter?

Experiments, we know, have been made again and again, but the principal feature has been too often overlooked.

In reference to propeller engines with gearings, it is worthy of inquiry what *is gained by them?* If they are intended to increase the number of revolutions of the propeller, we see where ever they are applied, that they do not. They only increase the size, weight, and expense, and occupy more room in the vessel. Propellers with equal diameter and pitch, will make rather more revolutions from a direct action steam engine with the same quantity of steam.

The mechanical law says, "*Apply the power as near the object as possible.*" And the words *stationary* and DIRECT ACTION, (no trunks,) are perfect teachers on the subject.

Philadelphia, September, 1851.

Translated for the Journal of the Franklin Institute.

Experiments on the Application of Electro-Magnetism as a Motive Force.

By M. ARISTIDE DUMONT.

The author announces in the following terms, the consequences to be deduced from the experiments reported in his memoir:

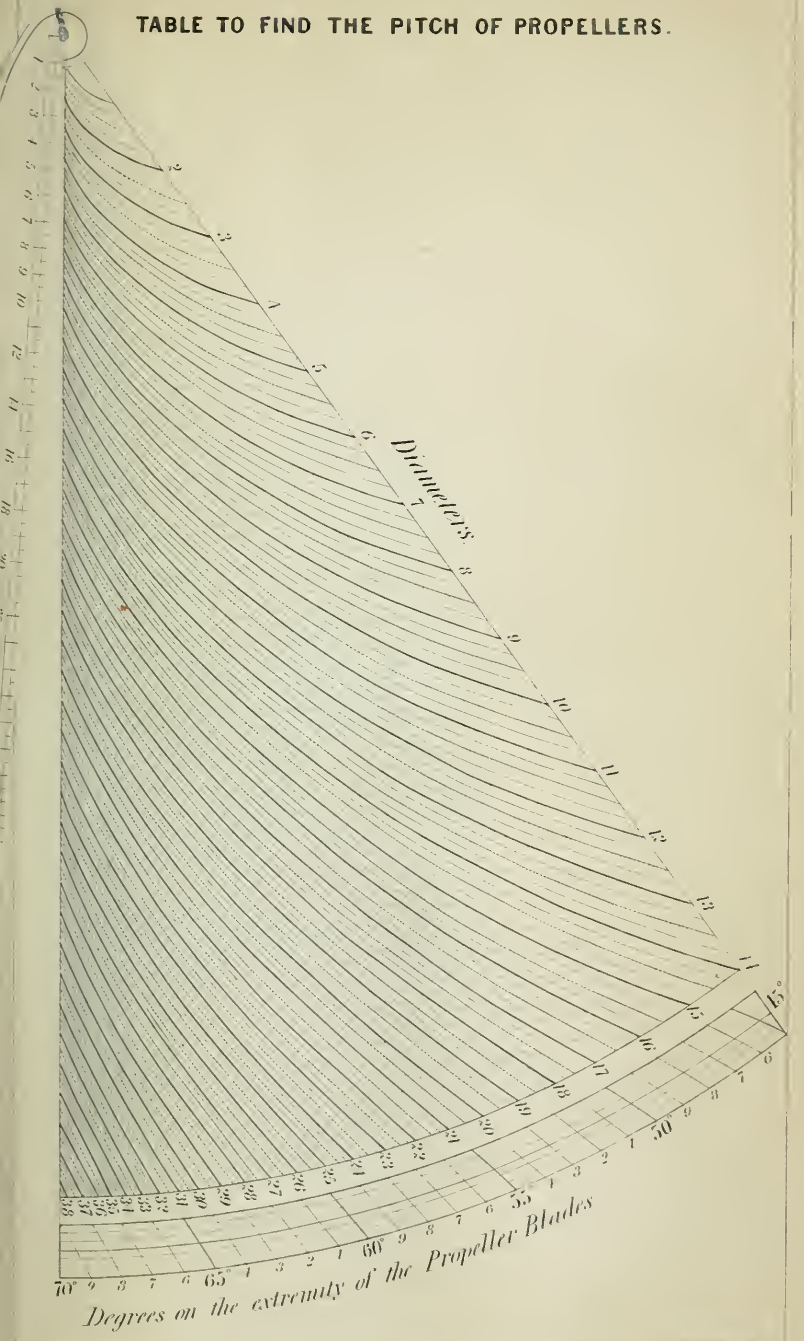
1. The electro-magnetic force, although it cannot yet be compared to the force of steam in the production of great power, either as it regards the absolute amount of power produced, or the expense, may nevertheless, in certain circumstances, be usefully and practically applied.

2. While in the development of great power, the electro-magnetic force is very far inferior to that of steam, it becomes equal and even superior to it in the production of small forces, which may be thus subdivided, varied, and introduced into trades and occupations using but small capitals, where the absolute amount of mechanical power is less exerted than the facility of producing it instantaneously and at will.

3. In this point of view, the electro-magnetic force assists, as it were, the usefulness of steam, in place of uselessly competing with it.

4. Other things being proportional, electro-magnetic machines with direct alternating movement, present a great superiority of the power developed over rotating machines; since in the first there are no compo-

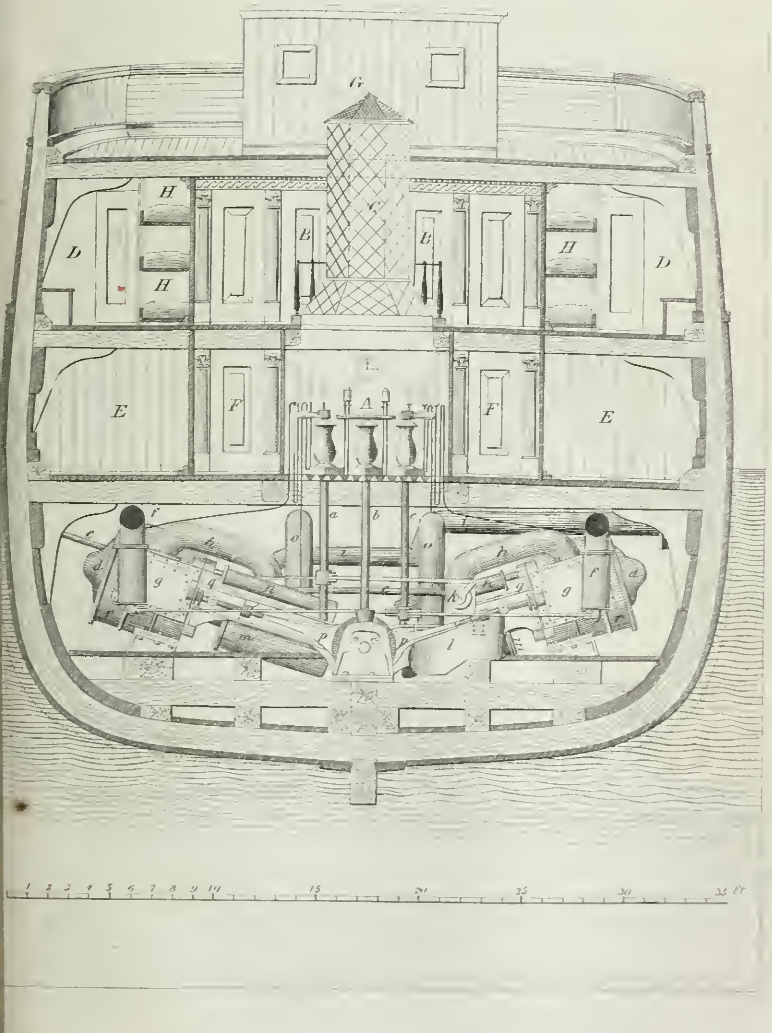
TABLE TO FIND THE PITCH OF PROPELLERS.



Suggestions for arrangement of Propeller Steam Engines

by

J. W. NYSTROM.



nents lost, and with the same expense a much more considerable power is obtained than with rotating machines.

5. In machines of direct movement, the influence of the currents of induction appears less considerable than in rotating machines.

6. Finally, in the calculation of the expense, it is proper to include deduction of the value of the sulphate of zinc produced, and to take into consideration, that in apparatus of any considerable size, the same battery may be used at the same time for the production both of the power and light.—*Comptes Rendus de l'Academie des Sciences, Paris, August* 25, 1851.

For the Journal of the Franklin Institute.

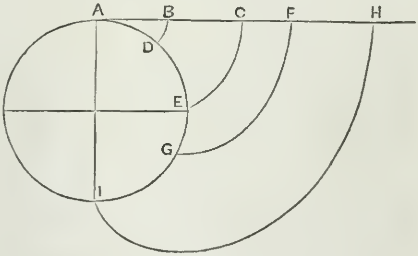
On the Gain of Power by Centrifugal Force. *By* T. W. Bakewell.

The recent controversy, particularly in New York, as to centrifugal force being susceptible of furnishing a gain of power by machinery adapted to that end, has induced the following remarks, in which I have endeavored to make the subject plain to the general reader.

Suppose a wheel in a horizontal position, the axis vertical, with hollow arms closed at the ends, and having a heavy ball in each, free to move in the arm. Let this wheel revolve with a given velocity, and the balls will press with a certain force against the ends of the arms.

If the velocity of the wheel be doubled, the ball pressure on the ends will be quadrupled.

Herein is the supposed gain; and it is my object to show it deceptive, and of no practical avail. When the wheel is under the first named velocity, imagine the end of the arm suddenly removed:—the ball would not then fly outward in the direction of its previous pressure, but be projected at a tangent to the wheel, as from A to B, in a given time. Under the double velocity, (the end of the arm being removed as above,) the ball would not fly outwards, in the direction of its previous quadruple pressure against the end, but would be projected to C, twice the distance of B, in equal time.



This result, is by the law of centrifugal force, and all other forms of dynamics, viz: in the simple ratio of the power used.

The quadruple pressure by the ball, under double velocity, is in this wise:—The ball, in revolving, has, at any and every point of the circle, a velocity in a tangential direction, as A to B, but is coerced from this straight line, by the closed end of the arm, compelling the ball to follow the circle, thus causing the pressure on the end; and the ball is found at D, instead of B, having been coerced from its straight line by a force, represented the by curved line B D.

In like manner under double velocity, the ball is found in equal time, at E instead of C; but then the force to coerce the ball from its (pre-induced) straight line, is represented by the curved line C E which is the quadruple of B D and has thus caused a quadruple pressure on the end of the arm.

These curves (involutes) may be formed by a thread, fast at A, and stretched along the line to B or C, brought down with a marking point to D or E, the thread winding round and against the edge of the circle. The curves are, at every part, perpendicular to a tangent of the circle, and truly represent the intensity of the required force by their length, and the varied direction, by their form, to overcome the tangential impulse, and are as the squares of the projectile velocities.

If the hollow arms of the aforesaid wheel were open at the ends, the ball being introduced near the centre, the rotation of the wheel would impel the ball outwards, by a continued effort of the ball to pursue the tangential directions, *which alone* is the cause of an apparently direct outward impulse, and the ball would leave the end of the arm under the last tangential direction and velocity, modified only by the outward motion acquired in its progress from the centre; and the velocity of this modified tangential projection of the ball would be in the direct ratio of the power used, as in the case previously cited.

Again, if to the end of the hollow arm be joined an elbow turning upwards, and a liquid, as water (or quicksilver,) be supplied at the centre, the water would rise in the upright part, in the ratio of the squares of the velocities, presenting the plausible aspect of a discharge, if taken from the bottom of the upright, being in quantity what would be due to the head.

But the flow of water, from the centre outward, being caused *alone* by the tendency to pursue a tangential direction (as in the case of the ball) —the supply to the discharge at the bottom of the upright would be in the direct ratio of the tangential velocity. The barren, passive, outward pressure at the end, or centrifugal force, never gives motion to any object in its own outward direction—but merely sustains and swerves the tangential impetus.

If in a given time, with any circle, the projectile and constant force be such that, starting from A, the ball would be impelled to a distance proportional to the circle, equal to F on the straight line, or to G if rotating in the circle, the centrifugal force F G, would be equal to the projectile A F or A G—and both equal to the diameter A I.

Let the above projectile force, A F or A G, equal gravity; the distance 193 inches, and time one second,—the diameter A I being also 193 inches.

Then, a wheel of 193 inches diameter, whose circumference moves at the rate of 193 inches in one second revolves in 3·1416 seconds, and has the centrifugal force equal to gravity.

Retaining the above circle:—If the projectile force, or the distance attained by it in a given time be greater in proportion to the circle, than A F or A G as A H or A E I,—the centrifugal force will be greater than the projectile, as curve H I, 476·208 is greater than line A H, or arc A E I, 303·164.

If the proportional projectile force, or distance attained, be less than

A F or A G, as A C, the centrifugal force will be less than the projectile, as curve C E, 119·052, is less than A C or A E, 151·582.

But in all cases the *ratio* of increase, or decrease, of the centrifugal forces (represented by the curves) is as the squares of the projectile velocities.

Cincinnati, October, 1851.

For the Journal of the Franklin Institute.

A Series of Lectures on the Telegraph, delivered before the Franklin Institute. Session, 1850–51. *By* Dr. L. Turnbull.

Continued from page 266.

Steinheil's Electro-Magnetic Needle Printing Telegraph.

The next telegraph in order of date of publication is that of Professor Steinheil, the first published notice of which I find in a letter from Munich, dated December 23d, 1836, published in the third volume of the *Magazine of Popular Science*.

"Prof. Steinheil has fitted up a telegraph here according to the plan of Prof. Gauss, and similar in principle to that, which connects the Observatory and Cabinet of Natural Philosophy at Göttingen." This telegraph was in operation previous to July, 1837, but was not published and described until August, 1838. "His Memoir was communicated for the *Comptes Rendus*, July 19, and published in September, 1838. According to the authority of Prof. Morse, Steinheil's telegraph was adopted by the Bavarian Government, and was in actual operation during his visit to Europe in 1838. According to the same authority, in 1838, "Professor Steinheil's telegraph was the only European telegraph that professed to write the intelligence. See Letter of Professor Morse to the Hon. C. G. Ferres, *Vail's Electro-Mag. Telegraph*, pp. 95, 97.

In the work of Dr. Schellen, published in Germany in 1850, it is stated that Steinheil's telegraph was in operation in 1837.

This is the first telegraph which I find on record, in which the earth was employed as half of the circuit—a most useful application of knowledge, gained at great labor, and not patented, but published freely to the world. His experiments are thus described by Dr. Schellen, in his work on the telegraph:

"Gauss had already conceived it possible to make conductors of the rails of a railroad, when Steinheil, in 1838, made the experiment, insulating the chairs of the rails by tarred felt; this was, however, imperfect insulation, as the circuit would not extend beyond thirty rails. To test the matter more thoroughly, he had some new rails constructed; but the points of contact were so numerous, and the establishment of a metallic connexion between the two rails by the wheels and axles of the cars passing over them so complete, that the current lost its force, and all idea of the measure was given up. This experiment demonstrating the conducting power of the earth, induced Steinheil to think of that as a means of return circuit, and thus dispense with one-half the wire. The fact by experiment he found verified, and immediately arranged his apparatus on this plan. This was a discovery of vast utility, and has contributed much to the extension of telegraphing. Steinheil says, you can make conductors of earth and water, as well as of wire, if you increase their size in proportion to the nonconductibility of the substance. Water was 100,000 times worse as a conductor than copper, and therefore the conducting surface should be made 100,000 times greater; in order to obtain this large conducting medium, it is necessary that the wires should terminate in submerged plates of the re-quired dimensions to include that medium between them. The same idea was afterwards brought forward by Dr. Cox, of this city, in regard to the use of railroads for telegraphic purposes, in September, 1845.

Steinhiel's alphabet is one of great beauty and simplicity, displaying the man of learning and refinement; as, for example, his musical bells, producing sounds which, striking upon a cultivated ear, conveyed a telegraphic language in imitation of the human voice. But he did not confine himself to the production of evanescent sound, he also employed the simple dot, so as to fix them permanently upon paper, that they could be recalled again. This form of telegraph is a combination of the successive fundamental discoveries of Professors Œrsted and Faraday, with the multiplicator of Schwigger.

I extract from the original paper of Steinheil, published in the *London Annals of Electricity*, March and April, 1839, an account of his telegraph, being the most complete which I can find on record:—

To Gauss and Weber* is due the merit of having in 1833, actually constructed the first simplified galvano-magnetic telegraph. It was Gauss who first employed the excitement of induction, and who demonstrated that the appropriate combination of a limited number of signs is all that is required for the transmission of communications. Weber's discovery that a copper wire 7460 feet long which he had led across the houses and steeples at Göttingen from the observatory to the cabinet of Natural Philosophy required no especial insulation was one of great importance. The principle was thereby at once established of bringing the galvanic telegraph to the most convenient form. All that was required was an appropriate method of inducing or exciting the current with the power of changing its direction without having recourse to any special contrivances for that purpose. In accordance with the principles we have laid down, all that was required in addition to this was to render the signals audible, a task that apparently presented no very particular difficulty, inasmuch as in the very scheme itself a mechanical motion, namely, the deflexion of a magnetic bar, was given. All that we had to do therefore was to contrive that this motion should be made available for striking bells or for making indelible dots. This falls within the province of mechanics, and there are therefore more ways than one of solving the problem. Hence the alterations that I have made in the telegraph of Gauss and by which it has assumed its present form may be said to be founded on my perception and improvement of its imperfections, in harmony with what I had previously laid down as necessary for perfect telegraphic communication. I by no means however look on the arrangement I have selected as complete; but as it answers the purpose I had in view, and it may be well to abide by it till some simpler arrangement is contrived.

*Gott. gel. Anz. 1834, p. 1273, and Schumacher's Jahrbuch, 1837, p. 38.

As an inductor or exciter I employ a rotating apparatus whose construction, speaking in a general way, is similar to those of Clarke, of London. The multipliers of which my inductor is composed, consist of a vast number of turns of fine insulated copper wire; and this arrangement is necessary in order that the resistance offered by the thicker wire completing the circuit, even should it be many miles long, may be but little increased. Of the galvanic influence excited during the entire half-turn of the rotating double multiplier, only a small portion is employed, and that when it is at the maximum of its energy. By this means the duration of the current is but very short, an arrangement which therefore, in a manner, can cause merely a momentary deflexion of the little magnetic bars employed for giving the signals. In order to heighten the action of these indicators as much as possible, they are surrounded by powerful multipliers. Small detached magnets are so placed near these indicators, that they are thereby brought back to their original position immediately that the induced current ceases, or in other words, as soon as the deflexion has taken place: I thus am enabled to repeat signals in very rapid succession. The same indicator can be brought with ease to make five deflexions in a second, succeeding each other as fast as the sounds of a repeater when striking. Hence if bells are placed at the proper striking distance from these indicators, they will ring at every deflexion produced, and as it is quite immaterial at what part of the wire, completing the circuit, the multiplier containing the indicator is inserted, we have it in our power to produce the sign excited by induction at any part of the course the wire takes. Should it be desired that the indicator instead of producing sounds should write, it is merely required to adapt to one end of the little magnetic bar a small vessel filled with a black color, and terminating in a capillary tube. This tube, instead of striking on a bell, thus makes a black spot upon some flat surface held in front of it. If these spots are to compose writing, the surface upon which they are printed must keep moving on in front of the indicator with a uniform velocity, and this is easily brought about by means of an endless strip of paper which is rolled off one cylinder on to another by clockwork. This is in a general way the construction followed in the telegraph erected here, a fuller account of which now would be out of place, as it may be found on referring to the appendix. As far as the employment of this telegraph is concerned, it may be fairly said to perform all that can be reasonably required of it. The excitation of the current is produced by half a turn of the indicator, and is equally available at all times. The sounds of the bells close to the person making the signals, and which being produced at the other station too are also audible there, become, by practice, intelligible as a language. Should they, however, be overheard or misunderstood, the communication presents itself simultaneously written down. This can be done with closed doors, without any but the parties concerned being aware of it: the communications may be made at any distance, and either by day or night, without any appreciable loss of time. There is, therefore, every reason to be content with the performance of the instrument.

It is not, however, to be denied, that the establishment of certain conditions indispensable to its action is, nevertheless, a matter of some difficulty. We allude to the connecting wire joining the stations.

It has been stated above that Ampere required more than sixty such wires, whereas thirty or so were sufficient for Sömmering. Wheatstone and Cooke* reduced their number to five; Gauss, and, probably in imitation of him, Schilling, as likewise Morse† in New York, made use of but a single wire running to the distant station and back. One might imagine that this part of the arrangement could not be further simplified, such, however, is by no means the case. I have found that even the half of this length of wire may be dispensed with, and that with certain precautions its place is supplied by the ground itself. We know in theory that the conducting powers of the ground and of water are very small, compared with that of the metals, especially copper. It seems however to have been previously overlooked, that we have it within our reach to make a perfectly good conductor out of water or any other of the so called semi-conductors. All that is required is, that the surface, that its section presents should be as much greater than that of the metal as its conducting power is less. In that case the resistance offered by the semi-conductor will equal that of the perfect conductor; and as we can make conductors of the ground of any size we please, simply by adapting to the ends of the wires, plates presenting a sufficient surface of contact, it is evident that we can diminish the resistance offered by the ground or by water to any extent we like. We can, indeed, so reduce this resistance as to make it quite insensible when compared to that offered by the metallic circuit, so that not only is half the wire spared, but even the resistance that such a circuit would present is diminished by one-half. This fact, the importance of which in the erection of galvanic telegraphs speaks for itself, furnishes us with another additional feature in which galvanism resembles electricity. The experiments of Winkler, at Leipzig, had already shown us that with frictional electricity the ground may replace a portion of the discharging wire. The same is now known to hold good with respect to galvanic currents.

The enquiry into the laws of dispersion, according to which the ground, whose mass is unlimited, is acted upon by the passage of the galvanic current, appeared to be a subject replete with interest. The galvanic excitation cannot be confined to the portions of earth situated between the two ends of the wire; on the contrary, it cannot but extend itself indefinitely, and it became, therefore, now only dependant on the law that obtained the excitation of the ground and the distance of the exciting terminations of the wire, whether it was necessary or not to have any metallic communication at all for carrying on telegraphic intercourse.

I can here only state in a general way that I have succeeded in deducing this law experimentally from the phenomena it presents: and that the result of the investigation is, that the excitation diminishes rapidly as the distance between the terminal wires increases.

An apparatus can, it is true, be constructed in which the inductor, having no metallic connexion whatever with the multiplier, by nothing more than the excitation transmitted through the ground, will produce galvanic currents in that multiplier sufficient to cause a visible deflexion of the bar. This is a hitherto unobserved fact, and may be classed upon the most extraordinary phenomena that science has revealed to us. It only holds good, however, for small distances. It must be left to the future to decide whether we shall ever succeed in telegraphing at great distances without any metallic communication at all. My experiments prove that such a thing is possible up to distances of 50 feet. For distant stations we can only conceive it feasible by augmenting the power of the galvanic induction, or by appropriate multipliers constructed for the purpose, or, in conclusion, by increasing the surface of contact presented by the ends of the multiplier. At all events the phenomenon merits our best attention, and its influence will not perhaps be altogether overlooked in the theoretic views we may form with regard to galvanism itself.

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* La France Industrielle, 1838, April 5, p. 3.

† Mechanics' Magazine, No. 757, p. 332. Silliman's Journal for October, 1837. Annals of Electricity, &c., Vol. II. p. 116.

To sum up in a few words what are the results of what we have here brought forward respecting telegraphic communications, we see that, with the present arrangement of the apparatus, no principle can be brought into competition with the galvanic telegraph, but that the establishing the metallic connexion indispensable to its action, although now materially simplified, still presents great difficulties in practice. Indeed, such a connexion is only practicable where it can be constantly watched, as, for instance, in the vicinity of railroads.

For very considerable distances without intermediate stations, galvanic or electric excitation must, on account of their rapidity, be always the best power to have recourse to. For less distances it yet remains open to enquiry whether, with proper modifications, some of the other methods we have pointed out would not be preferable, as they dispense with a metallic connexion.

To be Continued.

For the Journal of the Franklin Institute.

Trial Trip of the U. S. Screw Propeller Steamship of War, San Jacinto.

By Chief Engineer B. F. Isherwood, *U. S. Navy.*

This fine war steamer has just been completed and her trial trip made. A correct account of the vessel and her performance will be of general interest, and also professionally valuable.

The "San Jacinto" is one of the four steamships of war commenced by the U. S. Government in 1847, viz: the "Powhattan," "Susquehanna," "Saranac," and "San Jacinto;" all of which, with the exception of the first named, have been completed. With the exception of the last named, they all have the common paddle wheel. The "Saranac" and "San Jacinto," are of precisely the same dimensions and model, the intention of the government being to make the two vessels as nearly identical as possible, in order to try the relative merits of the two systems of propulsion.

It was originally contemplated to use for the stern arrangement, a *combination* patented by Ericsson, in 1849, the claim on which is as follows:

"What I claim as my invention and desire to secure by letters patent is, the above described location or arrangement of the propeller shaft, in combination with the rudder made with a slot or recess to admit of the play thereof, substantially in the manner and for the purpose specified."

Which purpose and manner is specified in the said patent as follows:

"Prior to my invention the leading objections to the use of a propeller at the stern of a ship, was the weakening of the ship by cutting the stern to form a recess for the propeller forward of the rudder, and thus carrying the stern post or the part with which the rudder is connected so far back as greatly to reduce the stability of the structure. To avoid this, the use of two propellers, one on each side of the run of the ship, was essayed, but this is well known to be even more objectionable, as the shafts in that case must pass out through the run of the ship so far from the stern post and keelson, to have sufficient room between the axis of the propeller and the run of the ship for the semi-diameter of the propellers, as greatly to strain the ship, and requiring, in addition to the complexity consequent on two propellers, outriggers at the sides for the support of the projecting part of the shafts, which for sea purposes is highly objectionable.

"Another serious objection was, the difficulty of access to the propeller for the purpose of repairs, and the resistance presented by it when sailing alone.

"To obviate these and other minor objections not necessary to enumerate was the object of my invention, the principle or character of which consists in passing the shaft of the propeller through the run of the ship, and by the side of the stern post, that one of the bearings may be attached thereto for strength and stability, the propeller being placed abaft the rudder, and as this location of the shaft would of necessity interfere with the play of the rudder, this part of my invention consists in combining the location of the shaft and propeller with the rudder made with a slot commencing at the outer edge, that it (the rudder) may have the requisite play."

The above arrangement was so far from being a novelty or invention by Ericsson, that it was proposed to the French Minister of Marine in a memoir addressed to him in 1841, by the Commandant, Henry Labrousse, and printed in 1843. On page 75 of the appendix to this memoir, under the head of Hull, will be found the following:

"Si le faux étambot était en bois, il faudrait, pour qu'il ne fût pas affaibli outre mesure, par l'ouverture nécessaire au passage de l'arbre, lui donner une épaisseur considerable, ce qui nuirait à l'action de la vis et à la marche, par suite du remous occasionné en arrière; on pourrait néanmoins faire passer l'arbre tangentiellement à l'un des cotes du massif."

Which I translate literally as follows:

"If the false stern post were of wood, it would be necessary, in order that it be not too much weakened by the hole for the passage of the shaft, to give it considerable thickness, which would be injurious to the action of the screw and the speed, (of the vessel,) by reason of the eddy caused astern; one could, nevertheless, pass the shaft tangentially by one of the sides of the dead wood."

It may also be as well to remark *en passant*, that the use of *two* propellers was never proposed, except for vessels of very light draft proportionally to their displacement, and then the reason for using them was, to obtain sufficient propelling surface; furthermore, the passing of the propeller shaft through the dead wood of the vessel, tangentially by the side of the stern post, weakens the stern of the vessel quite as much as passing the shaft through the stern post, while the serious inconvenience follows, of throwing the engines and shaft of the propeller out of the centre of the ship. In the "San Jacinto," the axis of the propeller shaft is 20 inches to port from the centre of the ship.

The foregoing plan of Ericsson's was persevered in by the late engineer in chief of the Navy, Chas. H. Haswell, who designed the boilers, engines, and propeller, (proposed not executed propeller,) as late as December last, when he was superseded by the present Engineer in Chief, General Chas. B. Stuart, who disapproving the propeller and general stern arrangement of the vessel, which was not then completed, though the engines and boilers were finished and in their places; a Board of Chief Engineers of the Navy was ordered by the Navy Department, to examine the vessel and propose whatever modification they deemed judicious. The report of this board fully sustained, *seriatim*, the objections of Gen. Stuart, and proposed the present plan of stern arrangement and propeller, which was at once executed.

In this arrangement the propeller (of entirely different proportions from that designed by Mr. Haswell) was placed next the stern post of the vessel, and a metallic rudder was curved over and abaft the propeller, being attached to the stern post above and below the propeller. The invention of this stern arrangement was made by myself and adopted by the board.

Engines.—The engines consist of two inclined cylinders with vertical air pumps; the cross heads, being placed at the upper extremity of the cylinders, are connected to a double set of cranks by two connecting rods to each cross head. The engines are connected by drag links.

The cylinders are 62½ inches diameter and 4 feet 2 inches stroke of piston. Space displacement of both pistons per stroke, 179·54 cubic feet.

Cost of Engines, (exclusive of boilers and propeller,) . .	$105,247
Total breadth occupied by engines, between extreme points, . .	29 feet.
Total length, " " " " . .	23 1-6
Total height from centre shaft to top of steam pipe, . . .	9½

Boilers.—The boilers are of copper and three in number; they contain in the aggregate, 195½ square feet of grate, and 5250 square feet of heating surface. They are of the double return drop flue variety. Cross area or calorimeter of first flues, 35 square feet; of second flues 35 square feet; of third flues, 32 square feet; area of smoke chimney, 34 square feet; height of ditto above grate, 65 feet; proportion of heating surface per cubic foot of cylinder, 17¾ square feet; aggregate weight of copper in the three boilers, 214,575 pounds; cost of ditto, $53,054·56; cost of labor on boilers, $39,705·53; making the total cost of boilers, $92,760·09.

The different kinds of copper were furnished in the following quantities and prices:

157,892	pounds	of plates at . . .	28 cents per pound
38,386	"	bolts " . . .	25 " "
18,297	"	rods " . . .	25⅞ " "

The three copper boilers of the "Saranac," containing 5127 square feet of heating, and 188 square feet of grate surface, designed by Chas. W. Copeland, contained the following quantities of copper at the annexed prices:

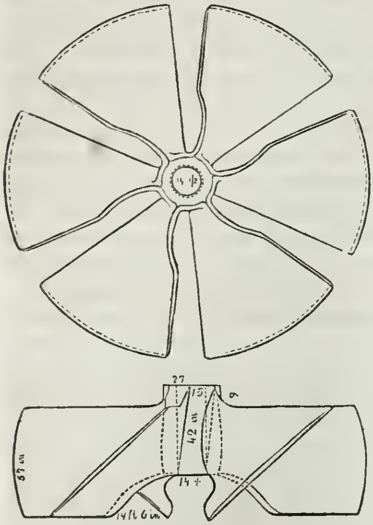
137,703	pounds of plates at	. . .	28 cents per pound
28,331	" bolts "	. . .	25 " "
27,927	" rods "	. . .	26 " "

Total, 193,961 pounds.

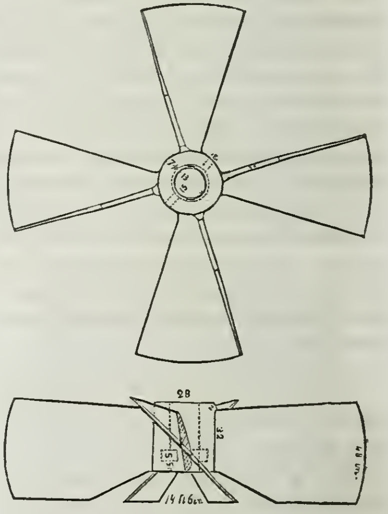
The boilers of the "Saranac" are of the same length, breadth, and height as those of the "San Jacinto;" cost of materials in the boilers of the "Saranac," $53,150·27; of labor on ditto, $23,747·55, making their total cost, $76,897·82, or $15,882·27 *less* than those of the "San Jacinto."

Propeller.—The propeller originally designed by Mr. Haswell, and condemned by the board of Chief Engineers, was 14½ feet diameter, 4¾ feet long on axis at periphery, with an initial pitch of 35 feet, expanding to 40 feet at the posterior end. The area, viewed as a disk, was 115½ square feet. The helicoidal area was 399 square feet; number of blades, six.

Screw Propeller originally proposed to be used. Initial pitch 35 feet, expanding to 39 feet.



Screw Propeller used. Initial pitch 40 feet, expanding to 45 feet.



The propeller recommended by the board and executed for the vessel, was 14½ feet diameter, 4 feet long on axis at periphery, 4 feet long on axis, at a diameter of 7½ feet, thence tapering to 2½ feet long on axis at hub, with an initial pitch of 40 feet, expanding to 45 feet at the posterior end. The area viewed as a disk was 65·48 square feet. The helicoidal area was 112,677 square feet; number of blades, four; space between the front edge of the propeller and the stern post of the vessel, (left for the rudder,) 6 feet.

The reason why the board recommended the increased pitch was, that the engine would, with that pitch, consume all the steam that the boilers could generate, cutting off at one-third the stroke of piston from the commencement; while the complex design, with the numerous joints and connexions of the engines, rendered it unsafe to work them at the velocity required in order to make the proper speed of the vessel, with the lower pitch of Mr. Haswell. The reduction in length was for the purpose of diminishing the surface of the screw, practice and theory both demonstrating the posterior portion of the blade to be of small efficiency compared to the anterior portion. In Mr. Haswell's propeller, a large portion of the surface of each blade overlapped or re-acted on the one following, which portion was useless for propulsive effect, and detrimental from its friction on the water. The six blades of Mr. Haswell's propeller were too numerous, not allowing sufficient space for solid water to enter between them, being as objectionable in this respect as too many paddles in a common paddle wheel, where it is well known, that with the usual proportions, each alternate paddle can be left out without sensibly increasing the slip of the wheel. Besides, with the 6-bladed propeller, there is encountered one-half more direct resistance from the thickness of the advancing edges of the blades, than with the four bladed propeller, and the six blades have also one half more resistance to overcome from the *adhesion* of the water to be divided by the blades. That this latter resistance is considerable, is proven by the experiments of Faraday, who ascertained "that the cohesive force of every square inch of water is equal to several hundred pounds."

The alteration of the relative positions of the rudder and propeller, was for the purpose of diminishing the leverage of the propeller weight on its shaft and on the stern of the vessel, as it had no outboard support. These were the principal reasons that controlled the board in their proposed changes. The board also estimated the slip of their propeller at 22 per ct.

The weight of the bronze propeller as cast and placed in the vessel, is 14,894 pounds; cost of ditto, $7,457.

The weight of the Stevens' bronze propeller for the U. S. Steamship, "Princeton" was 15,970 pounds. It was 14¼ feet diameter, 5 feet long on axis at periphery, and composed of 6 blades, having a pitch of 32·44 feet.

Performance.—The "San Jacinto" being brought to a draft of 15 feet 7 inches forward, and 15 feet 9 inches aft, was tried in New York Bay, Oct. 1, 1851. She made, in running a distance of 17¾ statute miles, taken from the chart published by the U. States Survey Office, 9·95 statute miles per hour against a strong wind on the port bow, estimated by the experienced pilot on board, as equivalent to a reduction of speed of one mile per hour. The tide was about slack at starting, but toward the close was ahead. The speed of the vessel in smooth water and a calm would therefore be 11 statute miles per hour. Mean revolutions of the screw per minute, 31.

With the initial pitch of the screw 40 feet, the slip would be as follows:

40×31×60=74,400 feet per hour=speed of screw.
5280×11=58,080 " =speed of vessel.
16,320 " =slip of screw.

or 21·935 per cent.

With the final pitch of the screw 45 feet, the slip would be as follows:

$$\begin{array}{rrll} 45\times31\times60= & 83{,}700 & \text{feet per hour} & =\text{speed of screw.} \\ 5280\times11 & 58{,}080 & \text{“} & =\text{speed of vessel.} \\ \hline & 25{,}620 & \text{“} & =\text{slip of screw.} \end{array}$$

or 30·609 per cent.

The mean slip would therefore be $\frac{21\cdot935+30\cdot609}{2}=26\cdot27$ per cent. The mean effective steam pressure on the pistons, by indicator diagrams taken from top and bottom of each cylinder, was 16·29 pounds per square inch, the horse power developed by the engines would therefore be as follows:

$$\frac{3067\cdot9\times16\cdot29\times4\tfrac{1}{6}\times(31\times2)\times2}{33000}=782\cdot45$$

A dynamometer was fitted to the screw shaft, and gave a mean thrust of 12,815½ pounds; the power exerted in propelling the vessel would therefore be

$$\frac{12815\tfrac{1}{2}\times968\ \text{(speed of vessel in feet per minute)}}{33000}=375\cdot92\ \text{horses.}$$

If we now estimate the power required to work the engines, overcome the load on the air pump, &c., at 2 lbs per square inch of steam piston, an estimation that will probably vary but little from the truth, we shall have 96·06 horse power absorbed in working the engines alone.

Taking from Morin's experiments, the friction of the load at 7½ per cent. of the power applied, and considering the power applied to be that developed by the engines, minus that absorbed in working the engines, we have for the power absorbed in the friction of the load, 51·48 horses.

Collecting the above, we have the following for the disposition of the power in the "San Jacinto:"

Slip of the Screw,	26·27	per cent.	or	205·55	horse power.
Propelling the Vessel,	48·04	"	"	375·92	"
Working the Engines,	12·28	"	"	96·06	"
Friction of the Load,	6·58	"	"	51·48	"
Leaving to be absorbed in the friction of the screw surface on the water, and the direct resistance of the edges of the blades, &c.,	6·83	"	"	53·44	"
	100·00			782·45	

From the above table it will be perceived that the total losses of power by the screw were, 26·27 per cent. of the total power developed by the engines in slip, and 6·83 per cent. in the friction of the screw surface in the water, &c., making 33·1 per cent.

It may be supposed that the slip of the "San Jacinto's" screw was too great for the best economical effect, and that if greater surface had been given to it, a better result would have followed. This opinion, though plausible, is not sustained by experiment.

The best proportioned screws, ascertained from a trial of many, for giving the highest speeds of vessel, were found in the small experimental vessels, "Archimides" and "Dwarf," to have slips of 25 and 30½ per cent. The screw giving the highest result in the experimental vessel, "Napoleon," had also a slip of 25 per cent.; which was likewise about the slip of the screw giving the best result in the "Rattler."

In using any propelling instrument for the transmission of power, a portion of that power is unavoidably lost in misapplication. In the common paddle wheel, this misapplication consists in giving a retrograde motion, in a direction parallel to the vessel, to the water acted on by the paddles, termed dip, and to a vertical depression and lifting of the water, termed oblique action—the total losses by the paddle wheel being the sum of the losses by slip and oblique action. In the screw, there is the same loss by slip, but the loss by oblique action, which does not exist with the screw, is replaced by another, viz: that of the friction of the screw surface on the water. The total losses by the screw would then be the sum of the losses by slip and friction.

It has been ascertained by experiment, that the friction of solid surfaces on water is directly as the surface and as the square of its velocity. In the same screw then, with equal velocities, the friction is as the surface; but the slip is by no means as the surface, but in a far less proportion, to be ascertained only by experiment.

The only reliable experiments made with this view, that I am in possession of, are those by Bourgois, made by order of the French government; and one of them is nearly a parallel case to the originally proposed and actually executed screws of the "San Jacinto."

Bourgois tried a screw of 6 blades, having a surface of $\frac{6}{7}$ths of the area of the diameter of the screw, viewed as a disk. The slip obtained was 37 per cent. Two of the blades were now omitted, and the remaining four placed equi-distant. The screw in this state was composed of 4 blades, having a surface of $\frac{4}{7}$ths of the area of the diameter, viewed as a disk; the slip was now found to be $38\frac{1}{10}$ per cent., or only $1\frac{1}{10}$ per cent. more than before. This experiment was pushed still further by the reduction of another blade, leaving the screw composed of 3 blades, with a surface of $\frac{3}{7}$ths of the disk; the slip now obtained was $41\frac{8}{10}$ per cent., or only $4\frac{8}{10}$ per cent. more than the first slip; showing that a reduction in the surface of one-half, only increased the slip from 37 to $41\frac{8}{10}$ per cent., or $11\frac{1}{2}$ per cent. of the last slip.

Supposing now the screw as originally proposed for the "San Jacinto," had been used, having about $1\frac{3}{4}$ths the projected and $3\frac{1}{2}$ times the helicoidal surface of the one actually used; and supposing the increased projected surface had decreased the slip in the above proportion of $11\frac{1}{2}$ per cent., or $3\frac{2}{100}$ per cent. of the actual slip of the "San Jacinto's" screw: there would then have been obtained a slip of ($26\frac{27}{100}$ — $3\frac{02}{100}$) $23\frac{1}{4}$ per cent. But the helicoidal surface having been increased $3\frac{1}{2}$ times, the friction would also have been increased in nearly that proportion; and as we see the friction with the present surface amounts to $6\frac{83}{100}$ per cent., it would have amounted with the $3\frac{1}{2}$ times surface to $23\frac{9}{10}$ per cent. Supposing the total power developed by the engine to have remained the same, in which case the available power for the propulsion of the vessel would have been diminished by ($23\frac{9}{10}$ — $6\frac{83}{100}$) $17\frac{7}{100}$ per cent., and increased $3\frac{2}{100}$ per cent. by the lessened slip, leaving a balance of diminution of ($14\frac{7}{100}$ — $3\frac{2}{100}$) $17\frac{5}{100}$ per cent. of the available power for propulsion; and as the speed of the vessel is in proportion to the cube roots of the powers applied, the speed would have been to the present speed in the proportion of $\sqrt[3]{1{\cdot}000}$ to $\sqrt[3]{0{\cdot}855}$; or, instead of being 11 statute miles per hour, would have been 10·44 statute miles per hour; always supposing the engines to develope the same power. The sum of the losses then of the proposed screw would have been $(23\frac{25}{100}+23\frac{9}{10})$ $47\frac{15}{100}$ per cent., instead of $33\frac{1}{10}$ per cent., the sum of the losses by the present screw. The present screw is therefore more economical by $14\frac{5}{100}$ per cent. of the power, without reckoning the practical advantages of decreased weight and cost of manufacture.

The screw proposed by the Board, and used on the "San Jacinto," has not the proportions they would have adopted, had they been designing the entire machinery of the vessel; but the engines, boilers, and stern of the ship having been completed before their labors began, they had only to adopt the best screw that existing conditions permitted. A longer screw was impracticable, with the stern of the vessel as built, and the surface was limited in that direction; more than four blades of the same length would have given more surface, but that surface would have been nearly useless, as the blades would have been so close together as to prevent the access of water of sufficient solidity, beside having the additional resistance of the additional edges of the blades. Nor could increased surface be obtained by lessening the pitch; for such was the complex design of the engines, the multitude of its connexions and moving parts, that it was unsafe to work them up to a speed that would be necessary, with a reduced pitch, to give the vessel the proper speed; in addition to which, the boilers would not have supplied steam enough for the increased number of revolutions.

Hull.—The "San Jacinto" is 203 feet long on keel, 210 feet long at load line, 215 feet long between perpendiculars, and 237 feet extreme length. The beam moulded is 37 feet, extreme 38 feet. Depth of hold 23½ feet. Deep load draft 16¾ feet. Depth of keel and false keel 15 in.

Displacement in tons of 2240 lbs., at launching draft of 10½ feet, 1080.

“ “ “	11¼ feet draft,	1156 tons and	1764 lbs.
“ “ “	13¼ “	1489 “	1242 “
“ “ “	15¼ “	1838 “	1658 “
“ “ “	17¼ “	2202 “	2055 “
“ “ “	16¾ “ (load draft)	2150 “	
“ “ “	per inch of draft at load line,	17⅓ “	
Area of immersed amidship section at	11½ feet draft,	273·81 square feet.	
“ “ “	13¼ “	346·55 “	
“ “ “	15¼ “	420·05 “	
“ “ “	17¼ “	496·05 “	
“ “ “	16¾ “	477·05 “	
“ “ “	15⅔ “	438·56 “	

The "San Jacinto" is barque rigged, and spreads 16,500 square feet of canvass.

Cost of materials for the hull,	$85,455
“ labor “	70,566
“ materials for masts and spars,	1,069
“ labor “ “	3,851
“ materials for boats,	574
“ labor “	1,546
“ materials for rigging and blocks,	1,018
“ labor, “ “	4,512
Other items,	25,000
	$193,591

The data furnished by the trial trip of the "San Jacinto," may be made available in determining *a priori* the friction of any other screw of known dimensions and revolutions per minute. We have seen that the friction of the screw of the "San Jacinto" amounted to 53·44 horse power; supposing the balance of the total power developed by the engines, after deducting for the "slip of the screw," for "propelling the vessel," for "working the engines," and for the "friction of the load," to be absorbed in the friction of the helicoidal surface on the water; the direct resistance of the edges of the blades being probably but small, as they were sharply chamfered. The screw surfaces were rubbed smooth.

In order to make this data applicable to other screws, the expression for friction must be reduced to some unit of weight, acting with a given speed on some unit of surface. The pound avoirdupois, 10 feet per second, and the square foot, are the most convenient for our purpose.

From many experiments, it appears that the law regulating the quantity of friction of solids on fluids, is different from that regulating the quantity of friction of solids on solids, and instead of being proportional to pressure and velocity, is proportional to pressure, surface, and the square of the velocity. Assuming these hypotheses to be correct, we will determine the value of the friction of one square foot of helicoidal surface, moving with the velocity of 10 feet per second, from the data of the "San Jacinto," premising—

As every helix of a helicoidal surface, from axis to periphery, is of a different length, increasing as the periphery is approached, and as each helix moves through its length per revolution of the screw, and as all the helices perform the same number of revolutions in the same time, it follows, that each helix will have a different velocity; and taking a helix to represent an infinitely narrow surface of the helicoid, it also follows that these different surfaces normal to the helices will have different frictions, in the proportion of the squares of velocities and the areas of the surfaces. It is then necessary to ascertain the velocities and areas of these surfaces. The problem can be solved approximately, geometrically, with but little trouble, and with more than sufficient accuracy for practical purposes.

By this method, the surface of the screw projected on a plane at right angles to the axis, that is, considered as a disk, is divided by concentric circles into any number of rings or *elements;* the greater the number of elements taken, the closer the result approximates the truth. The centre line of each element is taken as the length of the element, and is determined as follows:

The development of a helix upon a plane is the hypothenuse of a right angled triangle, whose base is the circumference normal to the distance of the helix from the axis considered as a radius, and whose height is the pitch. We have, therefore, the base and height of a right angled triangle, given to find the hypothenuse, and the hypothenuse or helix multiplied by the breadth of the element gives its area.

We have now all the quantities for the calculation excepting the pounds avoirdupois per square foot of surface for the speed of 10 feet per second. This we obtain by representing the unknown weight by x, and making the calculations with it for each element; then summing up the column so obtained, and dividing by 33,000, we obtain the expression in horse power multiplied by x. Making these calculations on the screw of the "San Jacinto," and returning to the data furnished by that vessel, when the friction of the helicoidal surfaces is given at 53·44 horse power, we ascertain, by dividing the 53·44 by the horse power multiplied by x as above obtained, the unknown weight in pounds avoirdupois—observing that the helicoidal surface must be taken for *both* sides of the screw.

In this manner the friction of one square foot of helicoidal surface moving in its helical path with a velocity of 10 feet per second, is determined from the data of the "San Jacinto," to be 0·6195 pounds avoirdupois.

An examination of the subjoined table will explain the *modus operandi* without further illustration.

It may be thought that the friction from the propelling face of the blade is greater than the friction from the opposite face, by reason of its pressure on the water. Should this be the case, however, the aggregate frictions from both sides of the blade would remain the same as though this pressure did not operate in inequality; for it is evident, that if this pressure *increases* the friction on the pressing face, it must, in an equal degree, decrease the friction on the face removed from the pressure.

Indicator Diagrams.—No. 1. From top of port cylinder; mean effective pressure per square inch, 14·9 lbs; revolutions of screw and double stroke of piston per minute, 31.

No. 2. From bottom of port cylinder; mean effective pressure per square inch, 14·95 lbs; revolutions of screw and double stroke of piston per minute, 31.

No. 3. From top of starboard cylinder; mean effective pressure per square inch, 20·15 lbs; revolutions of screw and double stroke of piston per minute, 31.

No. 4. From bottom of starboard cylinder; mean effective pressure per square inch, 18·75 lbs; revolutions of screw and double stroke of piston per minute, 31.

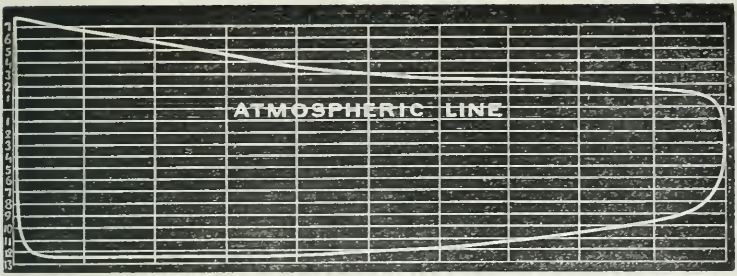
From the above and a number of other diagrams taken during the trip, with the engines working at 31 double strokes of piston per minute, the area of the mean effective pressures was 16·29 lbs. per square inch of piston.

Calculations on the Screw of the U. S. Steamship San Jacinto.

Diameter 14½ feet; length on hub, in the direction of axis, 2½ feet; length at diameter of 7½ feet, in direction of axis, 4 feet; length at periphery, in direction of axis, 4 feet; diameter of hub, 28 inches; pitch, 40 feet, expanding to 45 feet, mean 42½ feet; revolutions per minute, 31; number of blades, 4.

INDICATOR DIAGRAMS FROM THE U. S. STEAMER SAN JACINTO.

No. 1.



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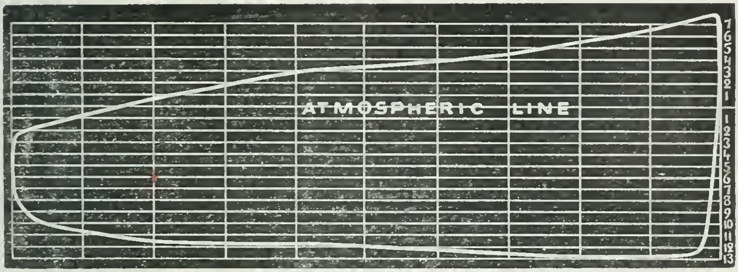

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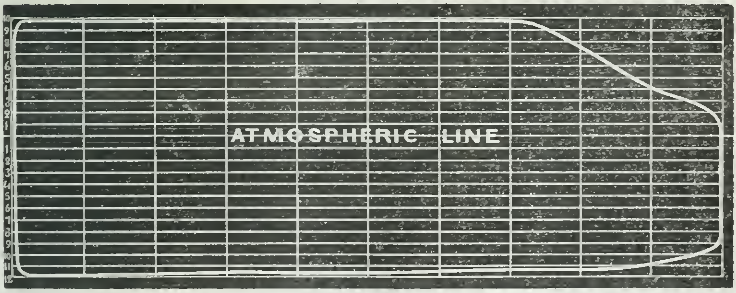

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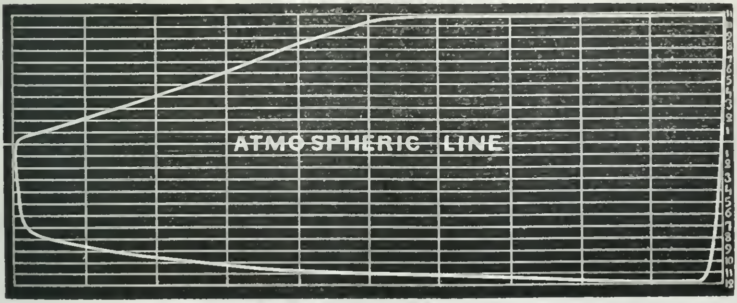


Pitch.	Radii of ele'ts.	Circumfer'ces normal to radii of elements.	Lengths of Screw in direction of axis at radii.	Fractions of Pitch used.	Lengths of Elements for one convolution of thread.	Lengths of elem'ts used.	Breadth of elements.	Helicoidal surfaces of elements.	Speeds of ele's pr. sec.	Speeds of ele'ts pr. min.	Friction, *both* sides of screw.
A	B	C $2\,B \times 3{\cdot}1416$	D	E $\frac{D \times 4}{A}$	F $\sqrt{(A^2+C^2)}$	G $F \times E$	H	I $G \times H$	J $\frac{K}{60}$	K $F \times 31$	L $\frac{J^2}{10^2} \times K \times 2\,I \times 0{\cdot}6195$ lbs.
Feet.	Feet.	Feet.	Feet.		Feet.	Feet.	Feet.	Sq. Feet.	Feet.	Feet.	
42·5	1·27	7·980	2·500	0·235	43·243	10·162	0·208	2·114	22·342	1340·53	17526·584
"	1·50	9·425	2·542	0·239	43·532	10·404	0·250	2·601	22·491	1349·49	21998·817
"	1·75	10·995	2·666	0·251	43·898	11·018	"	2·754	22·680	1360·84	23885·132
"	2·00	12·566	2·833	0·267	44·317	11·833	"	2·958	22·897	1373·83	26397·329
"	2·25	14·137	2·958	0·278	44·790	12·452	"	3·113	23·141	1388·49	28678·365
"	2·50	15·708	3·125	0·294	45·310	13·321	"	3·333	23·410	1404·61	31788·155
"	2·75	17·278	3·250	0·306	45·881	14·040	"	3·510	23·705	1422·31	34757·853
"	3·00	18·849	3·416	0·321	46·492	14·924	"	3·731	24·021	1441·25	38443·072
"	3·25	20·420	3·583	0·337	47·150	15·890	"	3·972	24·361	1461·65	43928·101
"	3·50	21·991	3·750	0·352	47·845	16·841	"	4·210	24·720	1483·20	47276·820
"	3·75	23·562	3·833	0·361	48·594	17·542	"	4·386	25·107	1506·41	51602·739
"	4·00	25·132	4·000	0·376	49·374	18·565	"	4·641	25·510	1530·59	57274·720
"	4·25	26·703	"	"	50·192	18·872	"	4·718	25·932	1559·95	62020·623
"	4·50	28·274	"	"	51·045	19·193	"	4·798	26·373	1582·40	65427·253
"	4·75	29·845	"	"	51·932	19·526	"	4·881	26·831	1609·89	70089·053
"	5·00	31·416	"	"	52·850	19·872	"	4·968	27·306	1638·35	75192·741
"	5·25	32·986	"	"	53·800	20·229	"	5·057	27·797	1667·80	80742·842
"	5·50	34·557	"	"	54·768	20·593	"	5·148	28·297	1697·81	86712·096
"	5·75	36·128	"	"	55·817	20·987	"	5·247	28·839	1730·33	93549·518
"	6·00	37·699	"	"	56·815	21·362	"	5·341	29·354	1761·26	100427·393
"	6·25	39·270	"	"	57·865	21·757	"	5·439	29·897	1793·82	108049·968
"	6·50	40·840	"	"	58·946	22·164	"	5·541	30·455	1827·32	116356·658
"	6·75	42·411	"	"	60·040	22·575	"	5·644	31·021	1861·24	125248·404
"	7·00	43·982	"	"	61·160	22·996	"	5·749	31·599	1895·96	134846·379
"	7·25	45·550	"	"	62·298	23·424	"	5·856	32·187	1931·24	145167·621
"	7·431	46·690	"	"	63·136	23·937	0·125	2·967	32·620	1957·22	76559·049
					Helicoidal Area of Screw,			112·677			1763947·285

$$\frac{1763947{\cdot}285}{33000} = 53{\cdot}45. \qquad \frac{J^2}{10^2} \times K \times 2\,I \times x = 2847372{\cdot}54\,x;$$ and

$$\frac{2847372{\cdot}54\,x}{33000} = 86{\cdot}284\,x;$$ and as $86{\cdot}284\,x = 53{\cdot}44$, $x = 0{\cdot}6195$.

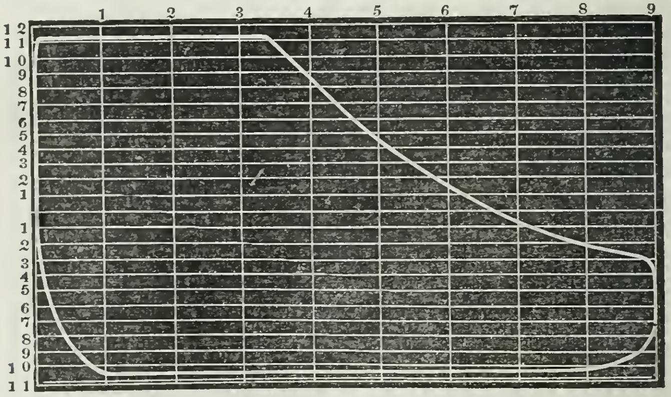
Comparison of the Results Obtained from the Screw of the San Jacinto, and the Paddle-Wheel of the Saranac.

Since writing the foregoing, I have obtained the log of the sister steamer Saranac, which enables me to make a comparison between the results obtained from the paddle wheel of that vessel, and the screw of the San Jacinto.

During the passage of the Saranac from Norfolk, Va., to New York, Oct. 15th, 16th, and 17th, 1850, the mean speed for 31 hours was 9·13 knots by log; revolutions of the wheels, 14·64 per minute; steam pressure in boilers per gauge, $13\frac{1}{6}$ lbs. per square inch; vacuum in condenser per gauge, 27 inches; throttle one-fourth open; cut off at $3\frac{1}{2}$ feet from commencement of stroke; smooth sea and *very* light breeze ahead. Mean draft of vessel, 15 feet 9 inches. Two inclined engines, cylinders 60 inches diameter, by 9 feet stroke.

Common paddle wheel, 28 feet diameter, 22 paddles in each wheel; each paddle 9 feet by 30 inches; immersion, lower edge of paddle $4\frac{1}{4}$ feet.

Indicator diagram from steam cylinder of the U. S. Steamship Saranac.



The mean effective pressure in the cylinder computed from the accompanying indicator diagram, taken under the above conditions, was 15·5 lbs. per square inch. The horse power developed by the engines would therefore be

$$\frac{(2827\cdot44\times15\cdot5\times(9\times2)\times14\cdot64)2}{33000}=699\cdot92$$

Taking the knot at $6082\frac{2}{3}$ feet, as used in the British Navy, 9·13 knots would be 10·518 statute miles. Taking the cubes of the speeds as the measure of the effects produced, and the indicated horse power as the cost of propulsion, and reducing them to proportionals; we shall have

	Powers.	Effects.
San Jacinto, ...	1·1291	1·1438
Saranac, ...	1·0000	1·0000

$$\text{and } \frac{1\cdot1438}{1\cdot1291}=1\cdot0130,$$

that is to say, the application of the power with the *screw* in the San Jacinto was more efficient than with the paddle wheel in the Saranac, in the proportion of 1·0130 to 1·0000; or the two systems in these particular cases, may be considered as equally good.

The slip of the centre of reaction of the Saranac's paddle wheel was 23·7 per cent., which is about the usual average given. The loss by oblique action calculated as the squares of the sine of the angles of incidence of the paddles on the water was 13·3 per cent. The sum of the losses by the paddle wheel being 37 per cent. The Saranac's paddle wheel thus gave as favorable results as are found in sea-going steamers, and the equal effect obtained from the screw of the San Jacinto, show it to have very perfect proportions.

The Saranac, when she commenced the above noted 31 hours steaming, had only 231·837 pounds of coal on board.

*Diving Vessels.**

In our late sojourn in Paris our attention was attracted to a diving apparatus working on the river Seine, in front of the Institute. It is a new and happy modification of the diving-bell, invented by M. Cave, the eminent engineer, for the purpose of descending to the bottom of rivers, and carrying on works there with greater facility than by the ordinary diving-bell. On the front of a dredging vessel is placed a large chamber, made of sheet-iron, having the form of an elongated hemispherical cup, 22 feet 9 inches in diameter, and 16 ft. 3 in. in height. In the centre of the bottom of the vessel there is a large opening which communicates with the river, and in it is placed vertically a large cylinder of sheet-iron, open at either extremity, and which can, by means of grooves, be lowered to any depth that may be required. When it is desired to examine the bottom of the river, it suffices to lower the cylinder; and, by the aid of an air-pump, a large quantity of compressed air is forced into the chamber. The water by that means is expelled underneath the cylinder, until at length the bottom of the river is left dry. The workmen can then descend inside the cylinder, and proceed with the work without any difficulty.

For communicating from without with the chamber, there is provided an ante-chamber, for persons to go in and out without allowing the compressed air to escape from the inner chamber. The doors of the inner chamber are hermetically closed, by which means the loss of compressed air is small, and is easily replaced. For the purpose of opening the inner door, it is necessary to open a valve to allow a small quantity of air in the inner chamber to escape into the ante-room, to restore a balance and make the pressure the same on both sides of the door. And a similar contrivance is necessary in the outer door; but before the valve is opened in the outer door, care must be taken to close the inner door and valve. There is another contrivance for forming an air-tight connexion between the vertical cylinder before described and the chamber. This is effected by a flexible joint or tube made of leather; one end is fastened to the bottom of the chamber and the other to the top of the cylinder. This leather flexible tube allows some play in the cylinder, so as to adapt it to various depths of water or variations in the depths of the river. The compression of the air is very easily accomplished by the steam engine which usually accompanies dredging vessels. The engine works two air-pumps, which communicate by a pipe to the chamber, and supply compressed air at discretion; of course, the density of the air must be in proportion to the depth of the water. It would appear that the workmen do not feel any particular difficulty in working in such an atmosphere; the only inconvenience in the augmentation of the density of the air is a slight pressure and noise in the ears. This vessel on the Seine is only an experimental one, to show that all descriptions of work can be performed under water with the greatest facility. M. Cave has already established two similar vessels for scouring the mud-banks of the Nile. The dimensions of them are much larger, the cylinders being 29 ft. 3 in. by 19 ft. 6 in.

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* From the London Architect for September, 1851.

Exposition of Foucault's Experiment.

To the Committee on Publications of the Franklin Institute.

It is somewhat surprising to observe that in all the explanations of Foucault's Pendulum Experiment which have appeared, not one has given, so far as I have remarked, a full exposition of its phenomena, and many have made false statements of its movements.

I propose briefly to consider its most obvious phenomena, and offer the accompanying exposition to the Institute, for disposal as it may think proper. J. S. Brown.

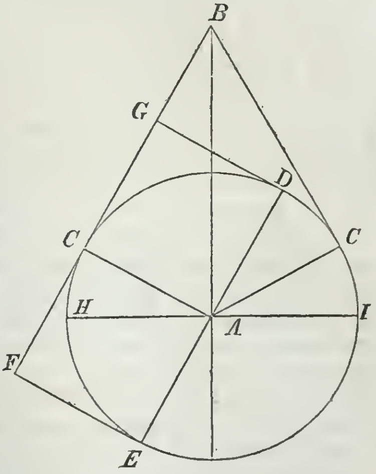
Washington, D. C., October 23, 1851.

The fact that a pendulum will invariably oscillate in the same plane, or in planes generated by the revolution or progression of the original plane, whatever may be the motion of its point of suspension, is the principle on which the phenomena of the experiment of Foucault depends. Yet the pendulum in this experiment, except at the equator and the poles, is supposed to depart from this very law, which rules its movements. For consider a moment. Having premised the obvious fact, that the motion of the earth in its orbit has nothing to do with the deviation of the pendulum, since its axis occupies positions ever parallel in every part of its orbit; and that in considering this experiment, we may therefore suppose the earth to have its one motion round its axis;—suppose a pendulum to commence oscillating in any direction, in any latitude, and to continue oscillating during an entire revolution of the earth. As it must constantly move in the same plane, or in planes produced by the revolution of its original plane of oscillation, when the earth has made precisely one revolution, the pendulum must, at that moment, oscillate in precisely the same plane in which it moved when first set in motion. The necessity of this is at once seen. At the equator it is said not to have deviated, which is true; at the poles it is said to have deviated through an entire circle, which is also true. In intermediate latitudes its deviation is said to have varied from nothing to an entire circle, proportional to the sines of the latitude, which is *not* true; for, if so, its planes of oscillation at the beginning and end of the revolution would not then coincide. But that is directly contrary to the fundamental law of its motion. But it may be said that in all intermediate latitudes it does deviate more or less, but nowhere sufficiently to complete a circle in one revolution of the earth. How can this inconsistency be explained into a consistency? Having met the difficulty I must conquer it, and propose to do so at once, by showing that the pendulum can have *five* varieties of movement consistent with the fundamental law of its deviation, and that it actually exhibits all those five movements in different positions on the earth.

Let A C, in the diagram, be a radius of the earth, terminating in the point where the pendulum commences its oscillation; hence the line B C represents the cotangent, and A B the cosecant of that latitude. The revolution of the right-angled triangle A B C about the side A B, corresponding with the revolution of the earth around its axis, will generate a double cone, one produced by the line B C, which is tangent to the meridian at each moment of the revolution, and represents the original direction of the pendulum's motion; the other generated by the radius A C, through which the plane of oscillation invariably passes. The planes of oscillation are described by the revolution or vibration about the line A D, passing through the centre of the earth, and parallel with the cotangent B C at the commencement of the revolution, of the plane D E F G, the original plane of oscillation. The angle which this plane makes with the generating plane A B C throughout their revolution shows the deviation of the pendulum, and depends on the latitude of the place and the motion of the earth on its axis for the given time.

Let the pendulum be suspended over the equator; the line B C is then parallel with the line A B, and the axes of the two generating planes coincide, making their angle of deviation nothing during their revolution. This is the first kind of deviation, which is *no* deviation.

Next, let the pendulum be placed in any latitude between the equator and 45 degrees. The axes of the two revolving planes make an angle with each other equal to the latitude; and as the plane of oscillation must always pass through the radius A C, it revolves with the triangular plane A B C, coinciding with it at the commencement of the revolution, and at the end of half a revolution, and reaching its maximum of deviation near the end of the first and third quarters of the revolution of the earth. Therefore, in all latitudes between 0° and 45°, the deviation of the pendulum gradually increases about 6 hours, and then gradually decreases to nothing at the end of 12 hours; then increases again at the next quarter of a revolution. This is the second variety of movement.



Then let the latitude be 45°. Here the plane of oscillation also revolves with the plane of A B C, but makes only one-fourth of a revolution to one-half of a revolution of the earth, and one-half a revolution to an entire revolution of the earth. Hence at the end of 12 hours the angle of deviation has reached 90°, and in 24 hours, or at the end of one revolution of the earth, 180°; the pendulum then moving in the original plane of oscillation, but actually oscillating in a direction opposite to its original. This is the only anomaly in its movements, but not contrary to the fundamental law of its motions.

Next, suppose the latitude any between 45° and the poles. The plane of oscillation here does not revolve, but vibrates by a reciprocating motion about its axis, and thus causes the angle of deviation to continually increase in variable increments throughout the entire revolution. At the end of half a revolution, the two generating planes coincide, their angle of deviation having reached 180°. At the end of the other half of the revolution they again coincide, their angle having reached a full circle. Thus the deviation of the pendulum in these latitudes, equals a whole circle in every revolution of the earth, but is slower in the first, and faster in the last part of each half revolution. This variation is greater the nearer the latitude to 45°, and less the nearer to 90°, till at the poles it is nothing, and the rate of deviation becomes constant, as will presently be seen. This constitutes the fourth variety of movement.

Finally, suppose the pendulum at one of the poles. Here the angle of the axis of the generating planes is 90°, and the oscillating plane does not move, the cotangent B C becoming perpendicular to the axis A B, and describing a circle in its revolution. Hence, it also describes a circle whose plane is perpendicular to that of oscillation; and the increase of the angle of deviation is constant, coinciding with that of the earth's revolution, and reaching an entire circle in each revolution. This constitutes the fifth variety of the pendulum's movement.

Thus, we find that at the equator the deviation of the pendulum is nothing; between the equator and 45° it increases to a certain angle, and then decreases to nothing each half revolution of the earth; at 45° it continually increases, reaching 90° each half revolution of the earth; between 45° and the poles, it makes an entire circle at each revolution of the earth, but in variable increments; and at the poles, it makes, in the same time, an entire circle in constant increments. In every latitude at the beginning and end of each entire revolution, and in every latitude but 45°, and at the beginning and end of each half revolution of the earth, the planes of oscillation coincide at 45°, the two planes being at right angles at the end of half a revolution. These generating planes have like movements in the first half and last half of each revolution, but in reverse order. The maximum of deviation between 0° and 45° varies in time between the 6th and 12th, and between the 12th and 18th hours, according to the latitude. Twenty-four hours are taken above as the measure of one revolution of the earth, which is not quite exact; but the error is trifling.

It remains now to give a rule for determining the angle of deviation at all times, and in all latitudes. The angle of deviation is a function of the latitude in which the pendulum is suspended, and the revolution of the earth on its axis. The following formulas will give the angle in every case.

Let L represent the latitude of the place; T the time of oscillation in degrees of the earth's revolution; x, the angular motion of the line A C (in the diagram) on the plane of oscillation; D, E, F, G, and y, the required angle. Then

$$\text{Sin. } x = \frac{\text{sin. } 2\,\text{L} - \text{sin. } 2\,\text{L} \times \text{cos. T}}{2},$$

and

$$\text{Cos. } y = \frac{\text{cos. L} - \text{sin. L} \times \text{sin. } x}{\text{cos. L} \times \text{cos. } x}.$$

For unimaginative mathematicians, who cannot see the movements of the revolving planes in the diagram, by the eyes of their mind, a convenient way to obtain a clear conception of them is, to cut out the triangle A B C, for the various latitudes desired from paste-board or veneering; and a plane to represent the plane of oscillation D, E, F, G, from like material. Then mark on a sheet of paper, a point indicating the centre of the earth, and a line to represent the line A B. Place the triangle A B C, as shown in the diagram, and the plane of oscillation at an angle equal to the latitude from that line. Then revolve the triangle A B C, and with it the plane of oscillation, taking care to keep it in contact with the line A C. The angle formed by the two planes in various parts of the revolution will represent the deviation of the pendulum, and the paper on which the planes are placed will be the original plane of oscillation.

The movements of the pendulum as here elucidated, are simply mathematical deductions from the supposition that the true cause is assigned for the phenomenon of the pendulum's deviation, which I doubt not. To ascertain by experiments if the actual movements coincide with the theoretical, would be a demonstration of the assigned cause. The principal difficulty would be to cause a pendulum to oscillate a sufficient time to observe all the effects spoken of above. I would suggest that a pendulum be caused to oscillate in a vacuum, which would probably, if well arranged, oscillate any desirable length of time, and, if in a glass vessel, would allow all its movements to be readily noted, while freedom from surrounding disturbances would be insured.

Note.—Our correspondent is in error in supposing that no explanation of this experiment has been given, involving a full exposition of its phenomena. The mathematical theory of it given by M. Binet, in the *Comptes Rendus* of the Academy of Sciences, is very complete, and the demonstration in our own Journal, by Mr. C. J. Allen, (page 103,) appears to us to be thoroughly correct, and may be easily extended to include all the phenomena. EDITOR.

FRANKLIN INSTITUTE.

Proceedings of the Stated Monthly Meeting, October 16, 1851.

S. V. Merrick, President, in the chair.
John F. Frazer, Treasurer.
Isaac B. Garrigues, Recording Secretary.

The minutes of the last meeting were read and approved.

Communications were read from the American Institute, New York, the Mechanic's Institution, Wheeling, Virginia, and the Maryland Institute, Baltimore, Maryland.

Donations were received from George Harding, Esq., and Dr. L. Turnbull, Philadelphia.

The Periodicals received in exchange for the Journal of the Institute were laid on the table.

The Treasurer's statement of the receipts and payments for the month of September was read.

The Board of Managers and Standing Committees reported their minutes.

New candidates for membership in the Institute (32) were proposed, and the candidates (7) proposed at the last meeting were duly elected.

On motion it was

Resolved, That the American Institute, New York, and the Maryland Institute, Baltimore, have the thanks of this Institute for their civility in extending invitations to the Institute to visit their exhibitions.

Resolved, That the President be authorized to appoint delegates to visit the exhibitions.

Resolved, That the Franklin Institute of the State of Pennsylvania, tender their congratulations to the founders of the new association at Wheeling, Va., for the promotion of the arts and the interests of mechanics, and express to them their warmest hopes for their success, towards which, no assistance which it is in the power of the Institute to grant, shall be wanting.

Resolved, That the Board of Managers be requested to inquire into the expediency of forwarding to the Mechanic's Institute of Wheeling, a copy of the publications of the Institute, and to institute with them a system of exchange of publications.

Dr. Rand brought before the Institute the Thermometrical Ventilator of Mr. Peter Teal, of this city, the action of which depends upon change of temperature. It is of a circular form, similar to the ordinary furnace register. The movable plate or valve being fixed upon a shaft with delicate bearings, and accurately balanced. Upon the side of the valve is an inverted syphon with a bulb at one end, the other being open; the lower part of the tube contains mercury, the bulb atmospheric air; an increase of temperature expands the air in the bulb, drives the mercury down one side and up the other, thereby destroying the balance and causing the valve to open by turning upon its axis. A diminution of temperature contracts the air in the bulb, causes the mercury to rise in the side of the tube, and closes the valve.

It is adjustable to any degree of temperature by means of movable weights attached to the shaft.

A number of specimens of cotton fibre were exhibited, prepared by Dr. Wetherill by Mercer's process, employing a solution of caustic potash, and some interesting remarks were made by G. W. Smith, Esq., who had examined the fibre by the aid of the microscope.

Mr. Thomas J. Weygandt, exhibited an improved magneto-electric machine, for medical use, with a new arrangement by which the shock is graduated by means of a glass tube, in which a wire is made to communicate with water so as to produce at first a slight shock; by gradually pressing down the wire attached to a spiral spring, the shock is received in its full force.

Mr. Charles E. Smith, made the following observations in regard to rolled tapered iron, illustrated by two specimens from the establishment of Reeves, Buck & Co., of Phœnixville.

Taper iron, or iron regularly diminishing in thickness, or width, or both, from one end to the other, has heretofore been made almost altogether by the hammer. The production of any such forms by the rolling mill, has been heretofore thought by many persons, to be impossible.

The principle and the merits of Mr. Clay's patent will perhaps be more readily understood if we first briefly review the nature of the attempts previously made. I believe among the first of these was the use of *eccentric rolls:* but the length of the taper was always limited by the length of the circumference of the roll, and the pressure was so unequal in the different parts of the revolution (the whole taper being necessarily given in a single revolution) that it was soon abandoned.

The next trial was with *bevel-wheels,* placed on the heads of the screws which hold down the top roll. This succeeded in part, but it was extremely limited in its application, and required a new pair of wheels for every change in the *rate* of taper. It was also necessary to reverse the motion of the wheels after the passage of each bar, in order to run up the screws before entering another bar.

Revolving eccentrics bearing on the journals were then suggested, but they were more complicated than eccentric rolls, without possessing any advantages over these in other respects.

Lastly, a *hydrostatic press* was proposed to force down the roller as the iron was passing through, but this was found not to act with sufficient promptness.

Mr. Clay's plan is more simple and more efficient than any of these, and at the same time it is unlimited in the length or rate of taper that may be obtained by it.

The principle on which it acts is that of hydrostatic pressure, or more properly, *hydrostatic resistance.* A small chamber, similar to that of the common hydrostatic press, is set on the top of each housing; the closed end of the press being uppermost, and a plunger entering from below; but instead of water being forced *into* the press, the chamber is at the first, filled with water, and the pressure of the iron in passing between the rollers, tends to lift the top one, which is held down by the plunger. An escape pipe provided with a valve, is inserted into the top of the chamber. When any upward pressure acts on the top roll, it is communicated by the plunger to the water, which escapes through the valve, and the roll rises.

When the valve is partially closed, the water escapes more slowly; and the rise of the roll, and, consequently, the taper of the iron, are more gradual.

Any rate of taper may thus be had by regulating the size of the opening of the escape valve. If the water is all driven out before the bar is entirely through the rolls, the top roll ceases to rise, and the iron becomes parallel from that point. Then, if the ends of the bar be reversed, and it be again passed between the rolls, the parallel portion will become tapered; thus we can get a bar,

First, Regularly tapered from end to end.

Second, Tapered part of its length, and parallel the remainder.

Third, Tapered from each end to a point any where in its length.

Fourth, Tapered at each end and parallel in the middle.

Fifth, Alternately tapered and parallel; (by alternately opening and shutting the valve as the iron is passing through the rolls.)

Sixth, Tapering in an increasing or diminishing ratio, (by gradually opening or closing the valve as the iron goes through.)

The principal use to which this iron has been thus far applied, is to form iron knees, for ship building; the storage of a vessel constructed with iron knees being about twelve and one-half per cent. more in bulk than that of one built with wooden knees. The arms of paddle wheels for steamers are flat bars, tapered either upon their edges or upon their sides. Short switches and pointers on railroads are regular tapers. Locomotive pedestals are made from bars tapered at each end and parallel in the middle. The common carriage axle is square next the journal, and tapered in thickness to the middle. Straps for walking beams and connecting rods and all kinds of levers are tapered. Anchor shanks are tapered "rounds," which have been passed through flat rolls, and have thus acquired an oval section. Windlass necks are tapered "squares." There are many things now made of common parallel bars of iron, which would be made of taper iron, were it not that the cost of forging is greater than that of the superfluous iron now used.

Mr. William Irwin, of Philadelphia, formerly of Chester, Pa., exhibited a working model of his "improved method of raising sunken vessels," for which he has recently obtained a patent, and explained the same to the meeting. This seems to be, in substance, an ingenious combination of "receivers," made of some water-proof material, and capable of exhaustion and inflation, attached to chains to which are fastened "purchase blocks" with "jamb-rollers and purchase halyards," together with a wedge of twisted rope in the shape of a marlin spike, used to prevent the halyards from slipping when the lifting power is being applied. When the position and dimensions of the vessel, and the weight of her cargo, are duly ascertained, chains of the necessary strength and receivers of sufficient power are selected, and the apparatus properly and readily arranged around the vessel; the receivers are then inflated, and the sunken ship is raised to the surface. The invention appeared to be both novel and meritorious, and can be applied, (as stated by the patentee,) to "supporting vessels off shore, floating them off and over reefs, rocks, and shoals, &c."

BIBLIOGRAPHICAL NOTICES.

Marine and Naval Architecture.

The United States now stand confessedly at the head of all maritime nations in Marine and Naval Architecture. Our ships command, by their speed and beauty of outline, not only the admiration of all who behold them, but the highest commercial freights that are to be obtained; and whether the talents of our builders are developed in pilot boats, yachts, ships, or steamers, the result for the last five years at least has been constant and increasing success. An acquaintance with several of our best ship builders in this city and New York, enables me to say with confidence, that this success has been obtained by what are usually termed practical men—operative mechanics, who by industry and ability have risen in their profession, and been enabled to develope practically their ideas, and with each vessel to improve. Our fastest and best ships have been the result of the application of these men, and in direct opposition to nearly all received opinions. The scientific publications on the subject, with one or two exceptions, are the same at the present day as fifty years since, and the practical man may look almost in vain for any assistance from scientific works. This is owing to the fact, that scientific men have not *practically* applied themselves to the business, and what they have written upon the subject has been the result of second hand information, acquired from practical builders, or the speculations of their own brain. The elements of a good vessel are so many and so various, depending on the general duty to be performed, that nothing but close and continued application will answer the purpose. But while these results have been obtained by practical men in a manner *they* may claim as *their* own, still it is none the less true, that their success has been the result of a proper application of scientific principles. A work from an operative ship builder, with the true outlines of many of our best vessels fully explained, and their success accounted for on the correct development of well known principles, has been much needed; and I think such a publication will be found in a book recently issued in New York, by John W. Griffiths, Esq., on Marine and Naval Architecture. Mr. Griffiths has himself worked practically many years at the business, and has felt the want of such a work as he has now been enabled, by several years of study, to produce. The execution of the volume is very superior. All the drawings are to an accurate scale, and of themselves are worth treble the price of the volume. In addition to this, there are twelve chapters devoted to all the various important points that are to be considered in the construction of merchant or navy vessels, including sea steamers. The method of reasoning is one that will readily commend itself to practical men, and I have no doubt will be fully appreciated by all those of a scientific turn who are willing to investigate the subject; among which, however, cannot be classed the editor of the London Mechanics' Magazine, who has made a most furious onslaught in the May and June numbers of that publication; having said much that had better remained unsaid, for the articles bear the impression of ill feeling and great haste, much of which has no doubt been produced by the claims made by Mr. Griffiths, in behalf of *this country, against England in particular*. Notwithstanding all that has been said by the editor of that Journal, I venture to assert, that no work on Marine Architecture can be produced, that will be so useful to the ship builder of the present day, as the work of Mr. Griffiths; and I am happy to know that a second edition is soon to be issued, that will contain all the lines of the yacht America. It is unfortunate for the Editor of the London Mechanics' Magazine, that these lines have not passed through what he terms "the crucible of science for several centuries," for then he might have claimed them as his own. It is also unfortunate for him, that the builder who designed her is a practical man; and still worse, that she was *designed* and built by him for a very fast vessel, (the editor admits that practical men may by accident build such,) thus proving that the design and execution were in accordance with each other.

Is it not a shame, that any man claiming to be scientific, should be so blind to self-respect as not to acknowledge the merit due to practical experience. True theory and practice are twin sisters, and he who overvalues one at the expense of the other, does great injustice to himself, and to those who are unfortunate enough to be guided by his example. The present practice of ship building does not, in this country at least, accord with that of the past. That it is an improvement, is proved by the rapid passages now made by our California and Canton ships; and although a change so great in form may not meet the approval of the Editor of the London Mechanics' Magazine, or have passed through the crucible of several centuries, (which he appears to think important,) I am very much afraid that we shall be inclined to stick to the present system, subject to still further improvements, until we find a better. B.

Appleton's Dictionary of Machines, Mechanics, Engine Work, and Engineering. Illustrated with 4000 *Engravings on Wood. Edited by* Oliver Byrne. New York: D. Appleton & Co. 1850. 8vo. 2 vols.

We are glad to see this very valuable compilation at length completed, and still more glad to find that it maintains its character for fulness and accuracy to the last. We regard it as decidedly the most valuable and reliable book of the kind in the English language. Mr. Appleton has had the good fortune to secure the services of an editor fully fitted, as well by his talents and education as by his energy and indefatigability, for the task; while his familiarity with the science of other countries, led him to avoid the great fault of English Encyclopedias, their confinement to English results. Mr. Byrne has done justice, to a great extent, to all, and in consequence, the state of general practice on any subject is better represented in his book than in any other that we know of. We observe, however, with surprise, that the last number of the second volume is accompanied by new title-pages for both volumes, in which the name of the editor is altogether omitted. What is the meaning of this? If, as would appear, from such examinations as we have been able to make, and from what we learn in other ways, Mr. Byrne is the one who has compiled and written the work—which is, in every fair sense of the word, a new one—he certainly is entitled to have his name on the title-page, and to receive credit for what he has done, and this is accorded in the old title-pages, which are now, however, replaced by new ones. We cannot at present imagine any state of circumstances which would justify an act of this kind; but Mr. Appleton certainly owes it to the public, to state his reasons for what appears to be an injustice, and we hope that those who have subscribed to the work will have it bound with the older and correct titles. F.

JOURNAL

OF

THE FRANKLIN INSTITUTE

OF THE STATE OF PENNSYLVANIA

FOR THE

PROMOTION OF THE MECHANIC ARTS.

DECEMBER, 1851.

CIVIL ENGINEERING.

On the Asphalted Macadamised Roads lately laid down in Paris. Compiled from the 'Annales des Ponts et Chaussées, 1850.' By M. DE COULAINE, *Engineer of the 'Ponts et Chaussées.'*[*]

Continued from page 302.

Application of the preceding System to Subterranean Passages, and to Cellars exposed to the Infiltration of Waters.—In the construction of railways, in the lower parts of vallies which are protected from floods by insubmersible dykes, it is often requisite to construct passages beneath the railways in such positions as are exposed to the infiltration of waters. This difficulty may be obviated by the use of a roadway with paving stones set in bitumen. The paving should be carried under the whole of the length of the bridge, and the parts of the slopes likely to be affected by the waters. To prevent lateral filtrations, the paving should be carried 4 inches under the masonry of the abutments, and a layer of asphalte, ¾-inch thick, should be formed upon the masonry of the abutments, passing through them, and extending a few inches beyond their inner face towards the land. After the masonry is carried up, this inner face should be rendered with asphalte; care being taken that the masonry be dry, and that the back rendering be made to join the horizontal layer. To insure its impermeability, it will be necessary to cover it with a coating of hot Bastenne bitumen. As soon as this operation is completed, it will be necessary also to bring the earthwork up carefully against the abutment, so as to support the rendering coat, which otherwise would sink down, owing to its elasticity. The earthwork backing must be well punned.

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[*] From the London Architect for April, 1851.

This horizontal paving will resist the pressure of the waters from below, so long as its weight shall exceed that required to resist the effort to raise it; should the latter be the greater, however, a modification of the system will be requisite. The following process was adopted in the execution of a passage under the railway from Tours to Nantes, at Saumur, for an occupation road:

A bed of concrete, 6 inches thick, was laid under the whole structure, so as to project beyond it 4 inches all round. When it was thoroughly dry, it was covered with a layer of asphalte about $\frac{3}{4}$-inch thick. During the whole of these works, the waters filtering through the ground were pumped away; and to render this operation more easy, drains filled-in with broken stone were formed under the concrete, and made to communicate with the wells. The coating of asphalte was then covered by a layer of masonry, about 1 foot 8 inches thick, bedded on a layer of mortar 2 inches thick, to prevent the asperities of the stones from tearing the surface of the asphalte. The abutments were then carried up, and their inner faces were rendered, as has been before described. This operation has perfectly succeeded, and the paving would at all times remain dry were it not for the rain waters. These are removed by being conducted to a well, from which they are pumped, as may be requisite.

The cellars of all the stations on the Tours and Nantes Railway, in the arrondissement of Saumur, have been protected in this manner from the waters of the Loire; and the system might be employed in many other similar positions, where the usual methods of construction would unquestionably fail.

Application to the Construction of the Vertical Sides of Basins.—Blocks of paving stone, bound together by bitumen, may be applied also to the coating of the vertical sides of basins or reservoirs, by being placed on edge. So long as the depth does not exceed 1 foot 6 inches, the usual thickness of the paving would be sufficient; when the depth is greater, they will require to be backed by masonry, as has been described for the pavements intended to resist a great effort. The coating at the bottom may be apparent, and immediately exposed to the action of the water.

The sides of reservoirs may also be executed in brickwork as follows: The bricks are to be first well brushed, to remove the dirt; they are then to be laid side by side, and parallel, the face which is intended to form the inside of the basin being upwards. They are then to be covered with mastic, without sand, and a little more liquid than usual, so that each of the bricks may be covered by a coat of not more than from $\frac{1}{6}$-inch to $\frac{1}{5}$-inch; this mastic, poured upon their faces, will necessarily flow between the bricks, and bind them together. Before the mastic has had time to cool, the bricks are to be separated from one another with a knife. The masonry is then to be executed with these bricks, faced with asphalte; bituminous mastic being used instead of mortar, so that the mastic working out from the joint may amalgamate with that upon the faces of the bricks.

The layer of mastic on the faces may be superseded by a double coat of Bastenne bitumen, laid on with the brush. But this operation, which would unquestionably render the bricks impermeable for a time, would require to be renewed every two or three years, whilst the system above described would probably last as long as the basin itself.

When the reservoirs are very small, that is to say, from 3 feet to 6 feet wide or in diameter, and about 1 foot deep at the utmost, the bricks may be laid on edge. Beyond these dimensions, they must be used flat or endwise. When the reservoir is more than 15 feet in diameter, or more than 1 foot 8 inches deep, it will be necessary to construct the vertical walls in masonry, whose thickness will require to be in proportion to the other dimensions of the reservoir. It should then be lined with bricks set in mastic, in the following manner:

After the bricks have been covered with mastic on the face, in the manner already described, care must be taken in using them, and bonding them in courses parallel to the interior wall of the reservoir, to leave a space of about $\frac{1}{2}$-inch. Then, in proportion as the courses are carried up, whether flat, edge, or endwise, according to the depth of the reservoir and the strength required for the lining, mastic must be poured into the space between them and the wall. It is essential that this operation should take place, course by course, and not at once, when all the courses are in position; no new course of bricks should be laid until the mastic is poured into the space between the lower ones, and until it is so far cooled as to have set with the wall into a solid body. Without this precaution, the lining might be blown out by the weight of the mastic. It will generally be sufficient to set the bricks on edge when there is a masonry wall built behind them.

Application for the Paving of Stables.—Stone pavings, set in bitumen, may be very successfully used in stables, for the purpose of preventing the impregnation of the soil by the urine of horses, and thus counteracting that fruitful source of miasma.

In the works executed by the French military engineers, it is usual to execute the paving in the usual way—to ram it well, so as to prevent any future settlement, to rake out the joints of the paving carefully to about 2 inches deep, and to fill them with mastic similar to that used for common footpaths. The latter operation must be performed on two separate occasions, to guarantee the mastic against too great a contraction, and to insure that the second application should be made on a surface perfectly dried, and still warm from the effect of the first.

With whatever care this process may be executed, it cannot insure the impermeability of the paving. A mastic thus prepared adheres but feebly to the paving stones; these are, to a great extent, only in juxta-position, and it is to be feared the urine must to a great extent filter between them in many points; the trampling of the horses must also aid this result. This danger might be obviated by covering the joints, at the moment of their execution, with mastic applied cold, as before described, whilst the first coat still retained some heat. But the preference decidedly should be given to the mode of paving first mentioned. The most forcible objection to the system adopted by the military engineers is, that it has been tried for roadways, and that the traffic has always destroyed them. The joints of the paving stones may also be filled-in according to any of the systems before described for the cold mastic.

CHAPTER XII.—SUBSTITUTION OF BITUMINOUS ROADWAYS FOR STREET PAVING IN PARIS, OR IN ANY OTHER TOWN—AND THE ADVANTAGES ATTENDING ITS INTRODUCTION.

The amount of the circulation in the streets of Paris—at the same time that it calls for very considerable expenses, in the first place—renders the execution of the repairs of paving much more difficult and numerous; so that, in spite of the pecuniary sacrifices of the town, and the efforts of the engineers intrusted with this branch of the public service, the streets are for the most part in a very bad state. To obviate this serious difficulty, efforts have been made either to improve the street paving, or to introduce some other description of roadway, which should have greater stability, require less frequent repairs, and be always in a proper state for the circulation.

Many improved systems of paving have been tried with the hope of attaining these results. The stones have been cut with greater care, and their dimensions have been altered so as to offer less resistance to the destructive action of the traffic. The price per metre superficial has augmented, it is true, in consequence of these various ameliorations; and the advantages obtained have certainly not compensated for the increased expense. The cost of the repairs has been less in the first instance; the public has been put in possession of roads much more beautiful in appearance, and the inhabitants of the neighboring houses have been for a time relieved from some of the noise occasioned by the passing traffic. But after a certain period, even these roadways are destroyed; some stones sink, some lose their edges, a great number of the joints become so worn as to form "ruts," and at length these roads become as uneven as the others.

This result might have been foreseen, for it is the result of the natural composition of paved roads. As the stones are independent of one another, it is physically impossible that the traffic can exercise the same effect on every one of them, either from a difference in their composition, or the difference of their dimensions, and of the position of their centre of gravity, or on account of the difference in the compressibility of the ground on which they are laid. It follows, that whatever care may be exercised in the selection of the stones, whatever perfection may be attained in their dressing or mode of laying, the settlements they are exposed to cannot be the same. The edges of the stones which settle the least being no longer protected by those nearest them, are worn away. And so soon as this double effect is begun to be produced, it proceeds with great rapidity, because the shocks become greater and greater, and the edges are more and more exposed to its effects. The slightest difference of level eventually leads to this result, so that, in fact, the best description of paved roads may be said to be always in a state of unstable equilibrium. To remedy this defect in a successful manner, it would be necessary to restore every stone to its position as soon as it became displaced. This is most effectually performed by lifting the depressed stone by means of bars, and raising its bed with sand.

But this method ceases to be applicable when it is to be used in roads of great traffic, such as the streets of Paris; for, in order to be of use, it must be constantly applied, thus interrupting the circulation in a most intolerable degree. It can, in such cases, only be applied at intervals too remote to prevent the stones from losing their shape, or from rounding on the edge. It then follows that the joints form small intervals when the stones are replaced, which continually increase, and which accelerate the production of the effect above cited. The wheels fall from one stone into the interval succeeding it, to rise again over the next stone, which they strike violently; and so on. The result is a series of shocks, whose intensity continually increases in proportion as the stones are beaten down and lose their form, and which destroys the roadway with so much the greater rapidity as the carriages are heavier and roll over with greater velocity. The lateral slip of the wheels, in the inclined parts of the roadways, augments this effect.

This want of connexion and homogeneity, in the elements of which the stone paving is composed, appears then to offer an insuperable difficulty to the attainment of a perfectly even roadway. But it is not the only disadvantage attending the use of stone in such cases. Firstly, owing to the hardness of the materials of which these roads are formed, they produce an incessant noise. Secondly, the foul waters which run down the channels cannot run away entire, but filter into the joints. And, lastly, owing to the ease with which they are displaced, paved streets offer the most suitable material for the construction of barricades in the moments of civil war. It was thus that in June, 1848, the streets of Paris were covered in a few hours with a series of citadels which cannon balls could hardly demolish. Much bloodshed would have been spared on both sides, if such materials had not existed so close to hand.

The government of the French Republic, deeply impressed with the magnitude of this danger, called the serious attention of the engineers of the Paris roads to the necessity of replacing the ancient system of stone paving by some other, which would not offer materials for the construction of barricades.

Macadamised roads would unquestionably have solved the problem; but the dust and mud they produce would be an insuperable objection in a street where the circulation is constant, as is the case in the centre of of Paris.

Wood pavings are objectionable—firstly, because they offer materials for barricades; and, secondly, because they have been found to be very costly in their maintenance, to last but a very short time, and to be excessively dangerous.

The macadamised roads in which the bituminous materials are employed, appear alone to satisfy all the conditions of the problem. In fact, the materials of which they are composed, like those of ordinary roads, are too small, and have too little consistence, to be of service in the erection of barricades. If they be considered with reference to their durability, and their adaptation to traffic, they offer every desirable guarantee, and are superior to the best description of paving, as has been demonstrated by the trial-piece near the Rue Laffitte. An objection has been raised to this system on account of its offering but little foothold to horses. The modification indicated in the previous part of this memoir (in which the macadam contains, over the whole of its surface, a mixture of flexible and resisting parts) entirely obviates this disadvantage.

It was anticipated that the bitumen would not have allowed the repairs necessary on account of any modifications of the gas or water pipes, to have been executed with sufficient ease. But we have seen that this is not the case; and that the repairs of the bitumen are as easily and as efficaciously performed as with any other description of paving.

It cannot be objected that the construction of the bituminous roadways would entail too great an expense. We have seen that the price of a metre superficial of this road, 4 centimetres thick, costs from 6·19 to 11·27 francs, whilst the ordinary street paving of Paris costs from 9 to 10 francs, and the best descriptions cost from 15 to 16 francs. M. de Coulaine expresses a very strong conviction that the method of constructing the bituminous roads, whose cost will not exceed 6·19 francs per metre, if combined with the system of repairing with materials applied cold, will give the most satisfactory results. There then appears every reason to believe, that so far from being the source of greater outlay, the new description of road will be the means of introducing a very considerable economy.

As to the cost of maintenance, the comparison made between the portions of the bridge of Saumur, executed in bituminous macadam, and those in common paving, justifies the anticipation that on this score also there will be a considerable economy. Even should this not be the case, these roads would still possess the great advantage of retaining much longer their state of perfect viability.

The principal advantages of the kind of road under consideration may be thus resumed:—

1st, They possess greater stability than any other kind of road in use, and do not require for their repairs those general operations which interfere so seriously with the circulation.

2d, They are constantly even, without being slippery, and are softer than the best macadamised roads.

3d, They obviate the noise of paved, or even of the best macadamised roads.

4th, They do not offer the materials for the formation of barricades.

5th, They guarantee the subjacent soil from all humidity.

6th, They dispense with the necessity for rendering an arch, if applied immediately upon it.

7th, They wear away very slowly, and, consequently, do not occasion much dust, or mud, thus obviating one of the great disadvantages attending the introduction of macadamised roads into the interior of towns.

8th, M. de Coulaine adds—(what seems more than hypothetical)—a further advantage, viz., that they are likely to be more favorable than any other kind of roadway to the application of steam for ordinary locomotive purposes, on account of their greater regularity and evenness, and of the absence of dust.

(*Note by the Translator.*)

Some liberties have been taken with the literal text of the original document written by M. de Coulaine; but the meaning has been as carefully rendered as the idioms of the two languages appeared to admit. The principal object proposed in the slight changes introduced, has been the condensation of the perhaps too diffuse essay contained in "*Les Annales des Ponts et Chaussées.*"

The translator would also beg to guard against the impression that he participates the enthusiastic confidence of the author in the perfect success of the modifications in the employment of the macadamised bituminous roads. He has known the results of the specimen at the end of la Rue Laffitte to be satisfactory; and that the traffic of eight years has but little affected it. But the macadamisation of the Boulevard has been too recently executed to allow of its being cited in any way beyond that of producing roads perfectly noiseless, and of very remarkable easiness of draft in summer. The system of street sweeping in Paris is far better organized than our own; but still it would appear that in the wet season, the Boulevards are inconveniently muddy. The expense of the maintenance also remains to be ascertained.

Enough, however, has already been proved of the advantages of the asphaltic roads to warrant our assertion of their superiority to any others in use where the absence of noise is a desideratum. In many of the London squares, near churches, hospitals, and places of public meeting, such roads are preferable to all others, if properly constructed. There does not appear to be any reason to doubt but that if they be properly swept, they would be as clean and as economical as any others.

Unfortunately, English engineers rarely pay sufficient attention to the practical details of their works, to allow us to hope that the delicate operations—almost chemical—required for the success of these roads, should be properly executed. Until the results shall have been, therefore, indisputably ascertained abroad, we must despair of seeing any serious attempts for their introduction into this metropolis, to the wants of which they appear to be admirably adapted in many cases.

On the Construction of Iron Vessels exposed to severe Strain. By WILLIAM FAIRBAIRN, F. R. S.*

In the construction of vessels—such as pipes, boilers, &c.—exposed to severe internal pressure, it is desirable we should have some knowledge of the strength and condition of the material used, and some fixed rule calculated to enable us to judge with accuracy as to the disposition of the parts, in order to apply the greatest strength in the direction of the greatest strain; and, in fact, so to dispose of the material, that every part of a vessel shall balance itself in its powers of resistance when subjected to uniform pressure.

To attain these objects, the author gave the results of his experiments on iron plates, first announced to the British Association, and subsequently published in the Transactions of the Royal Society. These experiments were originally undertaken to determine the strength of metal plates, beams, and angle-iron, as applied to ship building; and they have since been continued, from time to time, to determine the equally important nature of the construction of malleable iron bridges, boilers, and other vessels, such as caissons and malleable iron pipes, which are now beginning to be extensively used for pump-trees, and other articles connected with mining.

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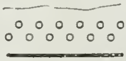
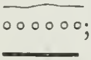
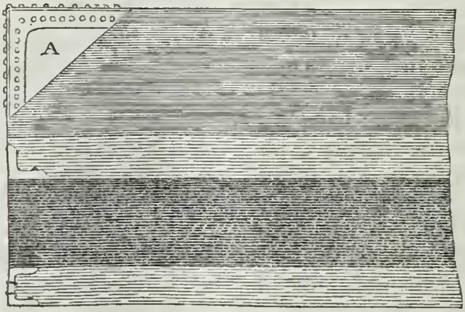
* From the London Architect for August, 1851.

To attain satisfactory data on the strength of iron plates, they were submitted to direct experiment—first, by tearing them asunder in the direction of the fibre, and afterwards across it; the tensile strength per square inch was as follows:—

	In the direction of the fibre.	Across the fibre.
Yorkshire plates,	=24·26	26·63
Derbyshire, "	=21·68	18·65
Shropshire, "	=22·82	22·00
Staffordshire, "	=19·56	21·01
Mean,	22·16 tons.	22·29 tons.

From this it will be observed there is no difference in the tensile strength of iron plates, whether torn in the direction of the fibre or across it; and that probably arises from the superior manner in which that article is now manufactured.

These experiments would, however, be imperfect as regards construction, if they had not been extended to the process of riveting, and on this point our information is of the most meagre description. Until of late years, many of our numerous constructions have been conducted under the impression that the riveted joint was not only strong, but stronger than the plate itself; whereas, more than one-third of the strength is lost by that process. Confirmatory of these views, it may be stated, that it was found by direct experiment that the strength of iron plates as compared with their riveted joints was as 100 : 70 for the double riveted joint, thus ; and as 100 : 56 for the single riveted joint, thus ; evidently showing a considerable diminution in the strength of those parts where the union of the plates is effected.



From the above data, practical formula was deduced, showing that the maximum resistance of riveted plates does not exceed 27,000 lbs. to the square inch; but, taking into account the crossing of the joints, and the adhesion of the two surfaces in contact, 34,000 lbs., or 15 tons, was found to be the ultimate powers of resistance of sheet iron plates, when riveted together similar to those in boilers and other constructions.

Mr. Fairbairn then exhibited sketches and diagrams in illustration of boilers of the cylindrical form, showing the necessity for adherence to form, and all those elements in construction so essentially requisite for the attainment of uniformity in the strength of all the parts. For these objects, gussets, similar to those adopted for giving stiffness and rigidity to the Britannia and Conway tubes, were in this case recommended, as shown in engraving, for imparting strength and retaining the flat ends of cylindrical boilers in shape.

The gussets which are shown at A, would diverge or radiate from the centre of the boiler, and might be increased in number according to the pressure the boiler was calculated to sustain; or, rather, equal to the strength of the other parts of the structure. The author earnestly recommended this principle of construction, as infinitely superior to stay-rods as a means of security against sudden and unexpected pressure.

Steam Brake for Locomotive Engines. *By* G. Maugham, C. E.*

The system of brake in question consists in fixing to the support or other convenient part of the boiler, a steam cylinder or valve *a*, from 6 to 8 inches in diameter; the piston or valve rod being connected with the ends of the levers *b b*, which act upon the blocks *c c*, constituting the break. A connexion is formed with the boiler, by means of a small steam pipe *e*, having a shut off cock fixed within reach of the engine driver.

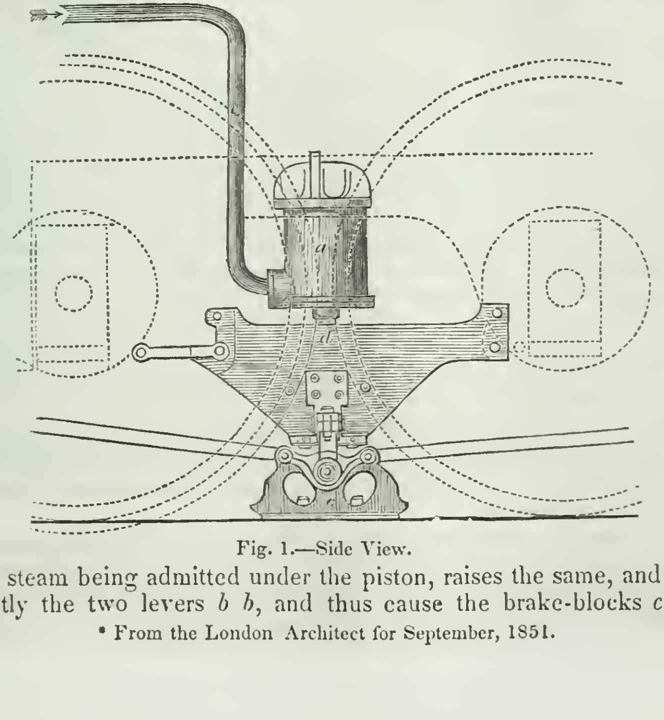


Fig. 1.—Side View.

The steam being admitted under the piston, raises the same, and consequently the two levers *b b*, and thus cause the brake-blocks *c c*, to descend upon the rails. The pressure of the steam gradually increases, until it has acquired the same force as that in the boiler. The pressure on the rails will then depend upon the force of steam per square inch in the cylinder or valve, multiplied by the leverage. The communication with the boiler being shut off, and the discharge cock opened, the brake-blocks will rise by means of the counterweight fixed on the levers. The effect of this break may be regulated at pleasure, by admitting more or less steam, as circumstances may require.

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* From the London Architect for September, 1851.

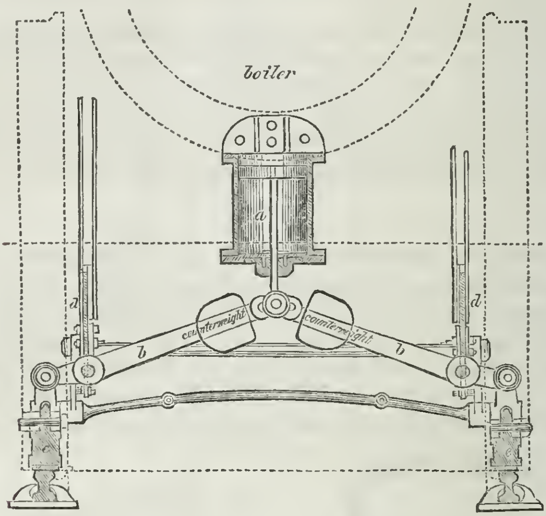

Fig. 2.—Transverse Section.

The above brake has been in use on the Namur and Liege Company's lines in Belgium during the last fifteen months, and daily experience proves its use to be highly advantageous and economical. The advantages arising from its application may be enumerated as follows:

1. In cases of immediate danger, the brake in question acts instantaneously, it being worked by the engine driver, who is in most cases the first to perceive the necessity of stopping the train.

2. The elasticity of the steam acting like a spring, allows the brake-blocks to rise over the inequalities of the line in passing over bad joints, switches, crossings, &c.; whence a great superiority over the brakes acted upon by a screw.

Lastly, its economy. By applying a steam-brake to locomotives, a brake carriage and its attendant may be dispensed with; thus decreasing the current expenses, viz: constant repairs to wheel tyres, guard's wages, to say nothing of the traction of the carriage.

The cost of a steam-brake (each) applied to a goods engine, is about 25*l.*; to keep the same in repair the cost is insignificant, the plates under the brake-blocks being the only pieces which require replacing from time to time.

Tender-wheels under the system usually adopted are very soon worn out, and require re-tyreing; by affixing a steam-brake to the engine, no necessity exists in ordinary cases to allow the tender wheels to slide or skid upon the rails in stopping a train. In order to test the value of the above system, an experiment was made on the Mons and Manage Railway, on an incline of 1 in 100, its length being about 2½ miles. To regulate the descent of a train of 42 loaded wagons, a single brake-carriage and the steam-brake were only made use of; whilst by the ordinary method, the same train required two brake-carriages and the tender brake. In the latter case, 14 wheels were exposed to rapid wear and tear, whilst in the former only 4 wheels were allowed to skid along the rails.

The above experiment fully bears out what has hitherto been stated, as far as regards the economy of the system. The utility of a brake of this description, in cases of extreme danger, cannot be questioned. Its extended application to locomotive engines would be a great safeguard to the public, and might probably be the means of preventing the recurrence of accidents similar to those which have recently taken place in England.

Mons, Belgium, July, 1851.

AMERICAN PATENTS.

List of American Patents which issued from October 14, *to November* 4, 1851, (*inclusive,*) *with Exemplifications by* Charles M. Keller, *late Chief Examiner of Patents in the U. S. Patent Office.*

16. For an *Improvement in Insulators for Telegraph Wires;* John M. Batchelder, Cambridge, Massachusetts, October 14.

"The object and design of this invention is, to afford a convenient and suitable holder or supporter for the wires of the electro-magnetic telegraph, and to secure a more perfect insulation of the wires, especially during rain-storms, than has heretofore been effected."

Claim.—"What I claim is, the re-entering angle at or near the base of the cup, as described, for the purpose of giving the wind a direction downwards, thereby preventing the rain that is driven by the wind, from entering the cavity of the cup.

"I also claim the annular disk, or washer, supported upon the centre shank, or rod, and so placed within or at the open or lower end of the inverted cup, as to prevent the free access of wind and rain to the inside of the cup.

"I do not claim the mode of imbedding the shank in glass, cast around it; but I do claim the application of the enamel, or glazing of porcelain, glass, or other vitrified non-conducting material, to a surface of metal, when the same is used for insulating the wires of the electric telegraph."

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17. For an *Improvement in Insulators for Telegraph Wires;* Zenas C. Robbins, Washington, District of Columbia, October 14.

Claim.—"What I claim as my invention is, my improved insulating supporter for telegraph wires, composed of the supporting and protecting cover, the winged tube, the wire holder, and the insulating segments, arranged and combined with each other, substantially in the manner herein represented and described."

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18. For an *Improvement in Imitating Marble;* Hiram Tucker, Cambridge, Massachusetts, October 14.

Claim.—"What I claim as my invention is, the process, substantially as described, of preparing and applying colors to glass, or other suitable transparent medium, so as to imitate the varied or colored appearance of polished marble or other mineral."

19. For an *Improvement in Shower Baths;* Wm. H. Brown, Worcester, Massachusetts, October 14.

Claim.—"What I claim as my invention is, the manner of hitching and unhitching the bath, for the purpose of suspending it when raised, and lowering it when desired, by means of the hooks, in combination with the looped strap, carrying a pulley, arranged and operating in connexion with another pulley, substantially as shown and described."

20. For an *Improvement in a Machine for Cutting Corks;* George Hammer, Philadelphia, Pennsylvania, October 14.

Claim.—"Having thus fully described my improved cork cutting machine, what I claim therein as new is, the cylindrical crown cutters, substantially as herein described, formed of an adjustable cylindrical smooth knife, surrounded by a burr cutter, the relative positions being adjustable, and the two being separable for sharpening, as fully set forth in the above description."

21. For an *Improvement in Machines for Twisting Fringes of Shawls, &c.;* John Nesmith, Lowell, and Wesley Sawyer, Dracut, Massachusetts, October 14.

Claim.—"We do not wish to limit ourselves to the special construction and arrangement of parts herein specified, as these may be variously modified within the range of our invention, by the mere substitution of mechanical equivalents; but what we do claim as our invention is, the method of selecting from the mass, the threads which are to be twisted into separate strands, by means of a reciprocating or vibratory finger, or the equivalent thereof, substantially as described, in combination with the first shell and wheel, or their equivalents, substantially as described, for giving the twist to the strands as described.

"We also claim, in combination with the first twister, the employment of the finger or fingers, or the equivalent thereof, for selecting and drawing together the strands which are to be twisted together to form the fringe as described; and in combination therewith, we also claim the second twisting wheel and shell, or their equivalent, substantially as described."

22. For an *Improvement in Grinding Mills;* William Newlove, Utica, New York, October 14.

"The nature of my invention consists in conducting the material to be ground, directly from the crushing rollers, by means of openings through these two grinding cones B and C, into a cavity in the smaller end of the inner revolving cone B, and from thence, causing the same to be distributed through the same openings between the said outer and inner grinding cones, B and C, where it is ground to the required degree of fineness."

Claim.—"I do not claim the original invention of the crushing cylinders, nor of a conical cast-iron mill for grinding substances; but what I do claim as my invention is, the mode and manner of feeding the material to be ground, directly from the crushing cylinders, through the opening in the outer cone C, into the cavity in cone B, through the four openings therein, as they pass, in turn, under the opening in C aforesaid, and thence through the same openings out of said cavity, between the two grinding cylinders B and C, and also the mode and manner of making the said openings, by the introvenient points *e, e, e, e*.

"And I also claim the arrangement of the teeth of the outer cone C, into two sets, the first section at the smaller end, being large and coarse, and turned so as to cut against the edges of the corresponding teeth of cone B, while the other section of teeth, or those towards the larger end, are finer, and turned in the opposite direction, so that their backs, and not their edges, are cut and ground upon, by the edges of the corresponding teeth of cone B."

23. For an *Improved Door Lock;* Chas H. Beatty, Wheeling, Virginia, October 14.

Claim.—"What I claim as my invention is, the combination, in the same lock, of the bolts provided with two sets of diagonal slats, or their equivalents; the slide running at right angles thereto, having pins, or their equivalents, and two key notches; and the drops acting as described, by which I make a right and left hand lock, which must be locked before the key can be withdrawn, and which forces the operator to turn the key in a certain, but different direction, according as either edge of the lock is uppermost."

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24. For *Improvements in Machines for Making Nuts, Washers, &c;* William Kenyon, Assignor to Joseph P. Haigh, Andrew Hartupee, and John Morrow, Steubenville, Ohio, October 14.

Claim.—"What I claim as my invention is, the compressing and discharging the nut, or washer, by means of the follower, or hollow piston, the bracket, the cross-head, and the moving die-box, constructed and operating substantially as described."

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25. For an *Improvement in Axle-boxes for Railroad Cars;* Robert Levington, Monroe, Michigan, October 14.

Claim.—"Having thus fully described my improved oil box, what I claim therein as new is, the sliding partition operated upon by a screw, or its equivalent, in combination with the inclined bottom, at the inner end of the packing space, condensing the packing more at the inner end of the packing space than at the partition, whereby the oil is prevented from escaping, as well as insuring a constant supply of oil to the journal, substantially as herein set forth."

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26. For an *Improvement in Water Wheels;* James L. Parker, Shirley Village, Massachusetts, October 14.

Claim.—"What I claim as my improvement is, the combination of the curved partition *d*, and the air space or passage *p*, with each two buckets, and for the purpose of causing the escape of air from the bucket into the next one in rear, all substantially as specified."

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27. For an *Improvement in Overshot Water Wheels;* Edmund Sheetz, Campbellstown, Pennsylvania, October 14.

"The nature of my invention and improvement consists in the attachment of a self-acting gate to each bucket of an overshot wheel, for the purpose of retaining the water in the bucket until it is carried to the lower part of the wheel, and thereby increasing the power and motion of the wheel."

Claim.—"What I claim as my invention are, the self-acting gates, attached to the buckets of an overshot water-wheel, in the manner described and for the purposes herein set forth."

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23. For an *Improved Padlock;* Thomas Slaight, Newark, New Jersey, October 14.

"The nature of my improved lock is the combination of the tumblers, bolt, and springs, in such a way as to cause the springs to perform their offices, to sustain both the tumblers and bolt in place, and carry them forward when drawn back by the key in unlocking, and to throw the shackle out when unlocked, and permit it to lock again without a key; the tumblers acting as counter bolts, to prevent the catch from being thrown open by a blow, or picked, moving with the bolt to which they are attached."

Claim.—"Having thus fully described my improved padlock and its mode of operation, what I claim therein as new is, the arrangement of the bolt, tumblers, and springs, as herein set forth; the tumblers and bolt being operated by the same springs, which also serve the purpose of throwing out the shackle, the tumblers projecting beyond the end of the bolt for that purpose, all substantially as herein described."

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29. For an *Improvement in Stoves;* Elisha Vance, Cincinnati, Ohio, October 14.

Claim.—"Having thus fully, clearly, and exactly described the nature, construction, and operation of my invention and improvements in stoves, what I claim therein as new is, making, as described, a space between the fire-place and the back oven the terminus of all the flues, and causing the vertical flue between the ovens to be an ascending or descending flue, by means of the register damper, as described.

"And I furthermore claim the combination of the first with the second feature, for the purpose and in the manner described."

30. For *Improvements in Lamps for Burning Vapor of Benzole, &c.;* Chapman Warner, Washington, District of Columbia, October 14.

Claim.—"What I claim as my invention is, the generator and lamp herein described, consisting essentially of chambers, long and narrow at their lower extremities, and fitted with pipes, or their equivalents, for the introduction of air; the said chambers communicating at their upper extremities, with a common reservoir, or vapor space, or chest, in which the vapors from the chambers are mingled, prior to burning, and the relative volumes of the inflammable vapors being regulated by the adjustment of the respective currents of air, whereby the regular proportionate and economical consumption of the fluids is ensured, and an equable light of the requisite intensity and volume is maintained, substantially as herein set forth."

31. For an *Improved Furnace Employed in Welding Shanks to Tools;* Jonathan White, Antrim, New Hampshire, October 14.

Claim.—"Having thus described my improvements, I shall state my claim as follows: what I claim as my invention is, the combination of the groove formed in the brick work above the fire, with the aperture *h*, *h*, leading thereto, and the reverberatory channel and exit flue leading therefrom, arranged with reference to each other and the fire, substantially in the manner described, whereby the flames, gases, &c., are caused to act upon both sides of such portions of the blade and shank as are to be welded to each other, and the other portions of the blade are protected from the heat, substantially as described."

32. For an *Improvement in Air Heating Stoves;* Gordon Williston, Charlestown, Massachusetts, October 14.

Claim.—"What I claim as my invention is as follows: that is to say, I claim the air space, the curved chamber, the series of descending pipes, and the ascending pipe, in combination with the air space, the chamber of combustion, and ash pit or chamber, all essentially in manner as specified."

33. For an *Improvement in Solar Lamps for Burning Lard or Oils;* John G. Webb, Williamsburgh, New York, October 14.

Claim.—"Having thus described my invention, I do not claim either the use or construction of the deflector, button, or any part of the lamp separately considered; but what I do claim as my invention is, the combination of the stationary or an adjustable button, with a deflector of metal, placed above the base of the flame, attached to any lamp constructed with an argand burner, for consuming lard, or crude oil, substantially arranged as set forth in the foregoing specification."

34. For an *Improvement in Argand Gas Burners;* John G. Webb, Williamsburg, New York, October 14.

"I am aware that a burner has been patented, covering a long expansive chamber, to contain the gas to be burnt; but in my burner the ordinary argand burner is used, which is public property; and the patent before referred to, covers a bell shaped mouth, formed by the lower end of the gas chamber, or burner; but in my improvement, no such bell shaped mouth is used, and I use a cone, which I am not aware has ever been used with any other argand hydrogen gas burner; and although a cone has been used with a circular wick burner, it will be seen that the argand carburetted hydrogen gas burner is entirely different, both in the material burnt, and in the construction of the parts."

Claim.—"Therefore, I do not mean to limit myself to the precise shape of the yoke, or to the proportions or size of the parts, as these must be varied according to the amount of draft required for different qualities of hydrogen gas; neither do I mean to limit myself to the shape of the burner, as long as the argand principle of the inner and outer draft is maintained; and though I described the cone as contracted at the base of the burner and slightly larger near the flame, as the best arrangement I have found in practice, yet some qualities of carburetted hydrogen gas, or a difference of pressure in the supply, may require the cone to be parallel to the top or contracted at the top; I therefore do not limit myself to the exact form shown at the top of the cone, because the variations thus stated are merely practical and contingent, while the main features of the application described remain substantially the same as set forth.

"I therefore claim the construction and use of an argand burner and button, with a cone, to regulate a supply of air to the base of the flame, in combination with an outside draft between the cone, and a suitable glass chimney, to complete the combustion, and turn the flame over the button; such parts being applied to burning carburetted hydrogen, or similar gas, substantially as described and shown."

35. For an *Improvement in Insulators for Telegraphs;* John Yandell, St. Louis, Missouri, October 14.

Claim.—"What I claim as my invention is, casting the glass insulators of magnetic telegraph and other wires, of a cylindrical form, with a flanch at one end, eccentric with the periphery of the same, its upper part being even with the top, and its lower part dropped slightly below the cylinder, and forming the bore of the cylinder, likewise eccentric with the periphery, so as to allow a greater body of glass to form at its lower part than at its upper part, where it is slit from its outer to its inner periphery, to allow the insertion of the wire, and inserting the insulator so formed into a horizontal hole, into which the wire is previously introduced through a slit at its side, bored through the post, or through a bracket secured on its side, or to a tree, and corresponding with the form of the flanch, which fits therein in such a manner as to insulate the wire from contact with the post, and prevent the glass from slipping round, and consequently the escape of the wire from the glass, as herein described, or in any other form substantially the same as the form and modifications above described."

36. For an *Improvement in Burglar Alarms;* John G. Bolen, City of New York, October 21.

Claim.—"My claims in the above described invention, I shall confine to a group or train of barrels, or firing chambers, in combination with the pierced fuse and vent holes, constructed, prepared, and operated essentially in the manner and for the purposes above set forth and described."

37. For an *Improvement in the Tops of Cans or Canisters;* Alfred Bliss, Newark, New Jersey, October 21.

Claim.—"Having thus fully described my invention, and the advantages thereof, what I claim therein as new is, the swaging or striking up the collar to receive the cover on the conical frustum, in place of soldering a separate one on, as heretofore."

38. For an *Improvement in Air Heating Stoves;* Charles A. Bogert, West Dresden, New York, October 21.

Claim.—"What I claim as my invention is, the combination of a revolving cylinder or cylinders with a fire grate, to form a heating apparatus, as above described."

39. For an *Improvement in Ship's Winches;* Thomas G. Boone, Brooklyn, New York, October 21.

"The nature of my invention consists in the investing of the power of the lowering motion of one load or burden, so as to make it aid in the hoisting of another; thereby greatly facilitating the loading and unloading of shipping, making the labor easier and the despatch greater."

Claim.—"Having described my invention, its mode of construction and operation, I do not claim the rigging of a winch or windlass with counter-falls, for the hoisting and lowering of burdens on the counterpoise principle, at whatever relative distance of hoisting and lowering it may be fixed, simply as such.

"But I claim the combination in a ship's winch, of the principle of adjustability with the principle of counterpoise; whereby I am enabled to vary the relative distances of the hoisting to that of the lowering motion, so as to adapt its action to various changes of the relative distances of the hoisting to that of the lowering, as required in the lading and unlading of vessels.

"I claim also therewith, the principle of using a hoisting in connexion with a lowering fall, so that the burden is hoisted by one fall, and lowered by the other, instead of interchanging the falls; so that each load or parcel is both raised and lowered by the same fall, as has been practised in other counterpoise machines; by which means my winch is more convenient to use than it would otherwise be, when the hoisting and lowering distances are dissimilar.

"2d, I claim a fall, or chain and hook, suspended over the deck or scaffold, working as a suspension chain and medium of transfer from the hoisting to the lowering fall of a ship's winch, whereby I am enabled, as described, to transfer packages or burdens, in sling, from the hoisting to the lowering fall, without re-slinging or otherwise resting them."

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40. For an *Improved Ore Washer;* Arnold Buffum, Brooklyn, New York, October 21.

Claim.—"What I claim as my invention is, the combining in the same separating cistern, the spiral channel, having a discharge aperture at the centre, and the revolving dasher, whose arms are immediately above the channel, for the purpose of separating metals from the impurities with which they are mechanically mixed, by acting in the manner substantially as described.

"And I claim this construction, irrespective of the use of quicksilver in the channel, which may in some cases be dispensed with."

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41. For *Improvements in Dressing Cotton Duck;* Horatio N. Gambrill, Baltimore, Maryland, October 21.

"The nature of my invention consists in subjecting the canvass to a jet or jets of steam, and passing it over, under, or around stationary heated cylinders, or friction rollers, and between and around rotary pressure calender rollers, while the canvass is in a state of tension."

Claim.—"Having thus fully described my invention, what I claim therein as new is, the process herein described, of softening and stretching cotton duck, by subjecting it, whilst strained, to jets of steam, and passing it over, under, or around heated stationary friction rollers, and between and around rotary pressing calender rollers, for the purpose herein specially set forth and described."

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42. For an *Improvement in Printing Presses;* John R. Hathaway and John P. Strippel, Norfolk, Virginia, October 21.

Claim.—"What we claim as our invention is, arranging upon a horizontally reciprocating carriage, a blanket frame, pressing cylinder, set of inking rollers, and sheet flyer, in such a manner that the two ends of the pressing cylinder shall roll upon the side rails; thus constituting a pair of the carrying wheels of the carriage, and producing a rotary motion of the pressing cylinder, as it passes over the type form, and whereby the requisite motion is given to the blanket; the several parts being constructed and arranged substantially in the manner and for the purposes herein set forth."

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43. For an *Improvement in Washing Apparatus;* James T. King, Baltimore, Maryland, October 21.

Claim.—"Having thus fully described my invention, what I claim therein as new is, the application of boiler h, with or without divisions, placed over the revolving boiler, resting on frame i, the bottom of which boiler forms the upper half of the flue m, by which both boilers are heated by the same fire, and from which the revolving boiler may be supplied with water, as herein fully described and represented."

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44. For an *Improvement in Apparatus for Regulating the Speed of Engines;* H. A. Luttgens, City of New York, October 21.

Claim.—"What I claim as my invention is, governing the throw of the variable cut-off eccentric, for the purpose of operating the cut-off, so as to regulate or equalize the speed and power of the engine, by means of the balance of or difference between the constant friction produced by the revolution of a pulley, which is hung loosely upon the same shaft with the said eccentric, and driven at a speed which always bears the same proportion to, but is greater than the speed of the shaft, and the variable friction of a brake shaft upon a wheel, which is also hung loosely upon the same shaft, and which receives or is acted upon by the aforesaid constant friction of the pulley, the lightness of the brake strap and the friction produced by it, being controlled by a common steam engine governor; the whole operating substantially as described; the said balance or difference of friction producing either an uniformity or difference between the speed of the shaft and of the wheel, and the said difference in speed causing motion to be given to any train of mechanism, substantially such as is described, in communication with the eccentric."

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45. For an *Improvement in Machinery for Enamelling Mouldings, &c.;* Robert Marcher, Cornwall, New York, October 21.

Claim.—"What I claim as my own invention is, the arrangement of the conveyer, constructed so as to form, in connexion with the moulding or the article to be enamelled, a reservoir to contain the composition, said moulding forming, as it were, a sliding bottom to the reservoir, by which means the composition is spread upon its surface, as set forth.

"I claim also the clamp for fastening and releasing the end of the article to be enameled; the whole being constructed and operating substantially in the manner and for the purpose described herein."

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46. For an *Improvement in the Mouth-piece for Wind Instruments;* Charles L. Meech, Preston, Connecticut, October 21.

"The nature of my invention consists in making a mouth-piece of the form commonly used, with the exception of a flanch or rim fitted to the outside of the upper part of the cup, and attaching thereto an artificial embouchure or lips, which, by blowing against, vibrates and sounds the instruments with great ease and effect."

Claim.—"What I claim as my invention is, a mouth-piece, with an artificial embouchure or lips attached to it, using for that purpose any elastic and water proof material which will produce the intended effect."

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47. For an *Improvement in Sugar Vacuum Pans;* James M. Miller, City of New York, October 21.

"My improvements consist in the mode of constructing steam pipes for sugar pans, and in their arrangement and combination with said pans, and with the boiler that supplies them with steam; by which arrangement the steam is conducted by the shortest possible course through pipes to every part of the pan, and the condensed steam or water has a free and direct course back into the boiler."

Claim.—"Having thus fully described my improved apparatus and its purposes, I claim as my invention, 1st, The evaporating and condensing tubes, constructed and arranged in the manner and for the purpose set forth; they being attached at one point only, through which the steam enters, have freedom to expand or contract without injury; and the evaporating tubes being combined at the centre of the series, as above specially set forth, with the boiler, the steam is conveyed from the boiler to the extremities of all the tubes in the most direct manner.

"I also claim connecting the filters with the vacuum pan, in the manner and for the purpose set forth, so that the vacuum pan shall perform the double office of making the vacuum in the filter and boiling in vacuo.

"I also claim the construction and arrangement of the condenser tubes above specified, the ends of said tubes being turned back inward nearly the whole length of the outer portion, as distinctly shown in the drawing."

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48. For an *Improvement in Running Gear of Railroad Cars;* William Nebinger, Sharpsburgh, Maryland, October 21.

"The peculiar characteristic of this improvement is in the construction and combination of a jointed perch or vibratory beam, placed on pivots at the centre of each truck, which combination constitutes a director of all the trucks in the train, on their reaching the curved portion of the track passed over by the truck under the locomotive; this perch beam is connected with, but not united to the other set of trucks, all working on a pivot journal in the same manner as the first set, and operated on by a suspended globe joint, admitting of a horizontal and slight vertical movement."

Claim.—"What I claim as my invention is, the employment of the bar B B, and ball and socket joint D E, attached to the ends of B B with a hinge, in combination with the pivot *c*, on the truck frame, for directing and turning said frames, (but not drawing the train by said ball and socket joint, as I do not dispense with the ordinary traction or coupling bar H,) and thus bring the axis of each truck coincident with the radii of the curve of the track, and lead the whole train over any point on the track previously passed by the locomotive, without requiring the action or aid of the flanches, or any of the wheels, except those on the locomotive; thus preventing the abrasion or wear of the rails, and liability of the train being thrown off."

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49. For an *Improvement in Piano Forte Strings;* Henry J. Newton, City of New York, October 21.

"My invention consists simply in coating the smaller strings of pianos with silver, in any of the usual ways, for the purpose of improving the tone; at the same time protecting them from the rusting action of the atmosphere."

Claim.—"I do not claim as my invention simply the application of silver to the strings of pianos, for the purpose stated, as that has before been done by wrapping the strings with silver wire; but when wrapped with wire, are liable to rattle when struck with the hammers: but what I do claim as my invention is, coating the smaller strings of pianos with silver, or an alloy thereof, for the purpose of improving the tone, and preventing the rusting of the strings, substantially as specified."

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50. For an *Improvement in Excavating Machines;* Benjamin W. Remy, Brookville, Indiana, October 21.

Claim.—"Having thus fully described the nature of my invention, what I claim therein as new is, the within described arrangement of parts, by which the elevators can be raised or lowered, to correspond with any irregularity or unevenness of ground.

"And I also claim making the operation of dumping self-operating, by means of the friction roller acting on the periphery of a pulley, permanently attached to the shaft, as herein fully described and represented, and for the purpose made known."

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51. For an *Improvement in Saddles;* John C. fr. Salomon, Cincinnati, Ohio, October 21.

"The nature of my invention consists in constructing saddles with pads, connected by hinges to a frame, to which, by means of a spring and levers, acting as springs, the seat is attached."

Claim.—"What I claim as my invention is, the combination of levers and spring, as set forth in the specification and drawings."

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52. For an *Improvement in Cast Iron Car Wheels;* Benjamin Severson, Schenectady, New York, October 21.

"The nature of my invention consists in having a solid hub and chilled rim, united by a single web or plate, so curved as to give an abundance of compensation for the contraction of itself and of the hub in cooling, after the rim shall have become nearly fixed, in consequence of being chilled; and also with a comparatively small amount of metal, to give the wheel all the required strength, either in a vertical or in a lateral direction."

Claim.—"I do not claim the chilled rim, the solid hub, or the single plate, with corrugations; nor do I claim simply radial corrugations: but what I do claim as my invention in the shape of cast iron wheels, is, the forming of said wheels with corrugations in the direction of the radii, which corrugations are reversed in passing from the hub to the rim, so that the parts convex at the hub, in passing towards the rim, gradually lessen their convexity, and then become concave, and increase in their concavity till they reach the rim; and so that on the other hand, the parts concave at the hub, in passing towards the rim, gradually lessen their concavity, and then become convex, and increase in their convexity till they reach the rim; the arches or central lines of the corrugations thus cutting obliquely, and passing through, alternately from one side and from the other, a plane supposed to be at right angles to the axis of the wheel, and to pass through the middle of the hub; and the said corrugations in their radial direction being either straight or curved; the whole constructed substantially in the manner and for the objects herein set forth."

53. For *Improvements in Machinery for Shaving, Nicking, and Re-shaving Wood Screws;* Thomas J. Sloan, City of New York, October 21.

Claim.—"Having thus described the principle or character of my invention, and the manner of constructing and using the same, I wish it to be distinctly understood that I do not limit myself to the precise construction and arrangement of the parts, as these may be variously modified without affecting the principle or mode of operation which I have invented and claim to be new.

"What I do claim as my invention is, so combining the shifting mandrel that carries the blanks with a shaving and nicking apparatus, substantially as described, that the blank, after being shaved to give the required form to the head, and whilst held in the same mandrel, may be shifted to the nicking apparatus, and after being nicked, re-shifted back to the same shaving apparatus, to have the burs removed by the same cutter that performed the first shaving operation, as herein set forth.

"I also claim the employment of two shifting mandrels, substantially as specified, in combination with the shaving and the nicking apparatus, substantially as herein described, so that the nicking operation can be performed on one blank, whilst the first and second shaving operations are being performed on other blanks, as specified.

"And I also claim giving to the mandrel or mandrels end play in their boxes, in combination with the permanent rest at the back of the mandrel and with the cutter, substantially as specified, by means of which the same position of the blank relatively to the cutter, is obtained for the second shaving operation which it had for the first, as described."

54. For an *Improvement in Box Openers;* George C. Taft, Worcester, Massachusetts, October 21.

Claim.—"What I claim as new in an instrument for opening boxes is, the combination of the lever with the brace; constructed and operating substantially as described, either with or without the heel."

55. For an *Improvement in Machines for Dressing Stone;* Joseph V. Tilton, Marcellas, New York, October 21.

Claim.—"Having thus fully described the construction and operation of my machine, what I claim therein as new is, the manner of attaching the pick-head to a strong but flexible steel spring, which falls on a box spring, whereby the desirable whip or spring blow is given to the pick, substantially as described.

"I also claim the combination of the lever F, and connecting lever G, and crank screw, for graduating the action of the pick, while cutting the furrow of millstones, gradually decreasing the force of the blow as the pick approaches the feather edge of the furrow, substantially as described and represented."

56. For an *Improvement in the Seeding Apparatus of a Seed Planter;* Cornelius C. Van Evory, Victor, New York, October 21.

Claim.—"What I claim as my invention is, giving the seed rollers an intermittent rotary motion, substantially in the manner and for the purpose set forth."

57. For an *Improvement in Machines for Peeling and Cutting Peaches;* Joshua O. Ward, Pleasant Valley, New York, October 21.

Claim.—"What I claim as my invention is, the application of a revolving rasping surface to the purpose of peeling peaches or other like fruits; and also the method of cutting peaches by a knife revolving in a box, having an opening in the bottom, in such a manner that the stone of the peach is struck out, and the pulp thereof cut into pieces proper for drying, in the manner above described.

"And I claim the aforesaid methods of peeling peaches, and of cutting the same, as well separately as when combined together, in the manner herein before particularly described."

58. For an *Improvement in Swinging Cradles;* Lucius F. Whitaker, Raleigh, North Carolina, October 21.

Claim.—"What I claim as my invention is, the self-adjusting pivot or connexion produced by the ball or weight M, suspended from the arc *o o*, by bent rods or hooks P P, said hooks having sufficient adhesion to communicate motion to the cradle from the motive power before described; thus constituting a sliding instead of a fixed pivot upon the end of the cradle, making it a matter of indifference on which side of the cradle the child may be lying, without stopping the motion of the cradle, which with the crank alone would stop."

59. For an *Improvement in Portable Water Closets;* George R. Willmot, Meriden, Connecticut, October 21.

Claim.—"Having thus fully described the nature of my invention, what I claim as new is, the manner of construction as described, and for the purpose specified, viz: the vessel B, resting upon the partition *a*, in the interior of the case A, and the circular rim D, projecting a short distance over the edge of the cover C, when on the vessel B, and resting upon the top edge of the vessel B, when the cover C is off of it, in order to form the seat; the whole arrangement being covered by the cover E of the case A, substantially as set forth."

60. For an *Improvement in Seed Planters;* Myron Cory, Jerseyville, Illinois, October 28.

Claim.—"Having thus described the nature and operation of my invention, I will now state what I claim as new. I claim the employment of the indicator I, having its ends bent as described, or in any other manner substantially the same, and secured on the main shaft, in such a manner that it can be disengaged or thrown into connexion with the wheel as desired, for the purpose of indicating the place where the corn has been planted, in the manner and for the purposes substantially as set forth."

61. For *Improved Means for Attaching Augers, &c., to their Handles;* Merritt S. Brooks, Chester, Connecticut, October 28.

"The nature of my invention consists in attaching handles to augers and other tools, by means of a ferrule, or cylindrical slide and socket; the socket is secured to the under side of the handle, and immediately under a mortise hole; the edges of the socket are beveled and fit into notches or grooves in the shank of the auger, or other implement; the upper surface of the socket is inclined, and the shank is moved in the socket, by means of the ferrule or slide, till the beveled edges of the socket bind firmly in the notches in the shank, thus securing the implement to the handle."

Claim.—"Having thus described the nature of my invention and the manner in which it is constructed, what I claim as new is, the method of securing augers and other implements to handles, by means of a socket, ferrule, or cylindrical slide, constructed as described, viz: the socket being placed underneath a mortise hole in the handle, and perforated with an oblong slot, the edges of the slot being beveled, to correspond to notches in the shank of the implement, the upper surface of the socket being inclined, and the shank moved along the slot, by means of the ferrule or cylindrical slide, by which the beveled edges of the slot bind or wedge in the notches, and the taper form of the shank drawn firmly in the hole through the ferrule slide, substantially as described."

62. For an *Improvement in Machines for Pegging Boots and Shoes;* Alpheus C. Gallahue, Metamoras, Ohio, October 28.

Claim.—"What I claim as new is, splitting the peg from the peg wood, and driving it into the sole of the shoe, by a single blow of the plate acting on the peg-wood, and forcing it upon the knife substantially as herein described.

"I also claim mounting the peg-wood, or block, in a vertical or sliding carriage, or the equivalent thereof, in combination with the stop plate, knife, and fingers, operated substantially as herein set forth."

63. For an *Improvement in Machines for Drying Bagasse;* Samuel H. Gilman, Cincinnati, Ohio, October 28.

Claim.—"Having thus fully described my improvements in apparatus for drying bagasse, I wish it to be understood, that I do not claim, for such purposes, a heated cylinder, revolving upon an inclined axis, such cylinders, in various forms, having been long in use; but what I claim herein as new, and of my invention, are, 1st, The arrangement (substantially as herein described,) of two cylinders, one so secured (by hollow bolts or rivets) concentrically within the other, as to leave between them an annular steam space, crossed by ventilating apertures, and the whole made to revolve around an inclined axis, for the expeditious drying (free from the danger of accidental ignition) of bagassse and other like substances.

"2d, The steam and condensed water pipes revolving together, (one within the other,) within a common journal bearing, and entering the steam space of the cylinder, in oppositely oblique directions, as described, for facilitating, at the same time, the discharge of the water and the admission of steam, during the revolution of the cylinder."

64. For an *Improvement in Swinging Cradles;* Selden W. Knowles, Middletown, Connecticut, October 28.

Claim.—"What I claim as my invention is, the combination of a cradle with pendulum rods and balls or weights attached thereto, and set in a frame so as to swing therein, in the manner and for the purpose above set forth."

65. For an *Improvement in Oil Presses;* David L. Latourette, St. Louis, Missouri, October 28.

Claim.—"Having described my invention, what I claim as new is, the combination of the heating plates with the steam chamber, substantially as herein set forth; the plates being moved parallel, and the steam tubes connecting them with the steam chamber, sliding in stuffing boxes, in a line with the motion of the plates, as above set forth, said steam chamber being placed in a proper relative position with the plates for that purpose."

66. For an *Improvement in Piano Fortes;* Frederick Mathushek, City of New York, October 28.

Claim.—"What I claim as my invention is, 1st, The manner, substantially as herein described, of placing or arranging the strings of a piano-forte, to wit: the shorter strings, or strings of the higher octaves, across the narrower portion of the instrument, and the longer strings, or those of the lower octaves, crossing them in the direction of the greatest length of the instrument, so as to include the greatest possible size of string within the instrument, for the purposes specified."

67. For an *Improvement in the Method of Moulding Kettles with Spouts;* Webster H. Pease, Dayton, Ohio, October 28.

Claim.—"Having thus described my method of moulding tea kettles, I do not claim any peculiarity, either in dividing the pattern, or using a green sand core; but what I do claim as my invention is, providing the pattern B, with two projections, or solid pieces, one on the underside of the spout portion, to prevent sand entering the spout when forming the green core of the body, and the other on the upper side of the spout, for forming a print in the sand, to receive the projection of a dry sand core, by the use of which, in connexion, the said dry sand spout core can be inserted in the drag portion of the mould, after the removal of B, but before the removal of A, and be held firmly in its required position; by which means the pattern A, is made to adjust the spout core, and greater truth secured in setting the spout core, and fewer defective casts result; in the manner set forth substantially in this specification and accompanying drawings."

68. For an *Improvement in Dairy Stoves;* Joel Stevens and H. J. Ruggles, West Poultney, Vermont, October 28.

"The object of this invention is to furnish for the dairy, a perfect, economical, and easily regulated heater for milk, in which it is impossible to burn the milk, and that is so constructed that the heat can at once be thrown off from the milk, by the simple movement of a compound valve."

Claim.—"Having thus fully described the improved apparatus and its mode of construction, what we claim therein is, 1st, the arrangement of the flues and valves, in combination with a water pan and fire box, substantially in the manner and for the purpose set forth.

"We also claim the combination of flues and valves, as herein specifically mentioned, for the purposes described."

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69. For an *Improvement in Machines for Taking Yeas and Nays;* Thomas B. Stout and James F. Morell, Keyport, New Jersey, October 28.

"Our invention may be divided into several parts, which are not necessarily connected, but which, when properly combined, effect the several operations of taking votes; of separating the affirmative and negative votes, of showing which class preponderates, of enumerating the number of each class, and of recording the votes, so that they can be read off as soon as they are taken; while at the same time, it effectually prevents mistakes in voting, as it shows whether any person's vote has been counted on both sides of the question."

Claim.—"What we claim as our invention is, the method of dividing the yea and nay votes, and showing the vote, by weighing the yea and nay balls, or their equivalents, in the opposite pans of a scale beam, substantially as herein set forth.

"We also claim the method of enumerating the votes upon a question, by weighing the balls, or their equivalents, by spring balances, or their equivalents, whose indexes indicate the number of ballots in their respective scale pans, substantially as herein set forth.

"We also claim the combination of the scale beam and spring balances, or the equivalent thereof, arranged substantially as herein described, for the purpose of showing, simultaneously, both the number of votes taken on each side of the question, and the relative values of the two sets or classes of votes, as herein set forth.

"We also claim the employment of mechanism, for the purpose of recording the vote, and showing whether it is yea or nay, at a single operation, substantially as herein described."

"We also claim the employment of mechanism, for the purpose of recording the vote, and showing the enumeration thereof, at a single operation, substantially as herein described.

"And lastly, we claim the employment of mechanism, for the purpose of recording and enumerating the vote, and showing whether it is yea or nay, at a single operation, substantially as herein described."

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70. For an *Improvement in Cements for Grinding Cylinders;* Jacob Stephan, Assignor to P. A. Schwartz and J. Stephan, Boston, Massachusetts, October 28.

"The nature of my invention consists, first, in the peculiar compound I employ; secondly, in the manner of employing it in the manufacture of the grinding cylinders for carding machines and other purposes, or other metallic, or wooden, or any other surfaces, wherever it is employed."

Claim.—"Having thus fully described my improved composition, and the manner of applying it, what I claim therein as new is, the composition herein described, consisting of the whey of milk, vinegar, glue, spirits of wine, and ether, substantially in the manner and for the purpose set forth.

"I also claim the combination thereof with emery, to construct a grinding cylinder, or other surface, in the manner described."

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71. For an *Improvement in Machines for Printing in Colors;* Richard S. Weaver, Maysville, Kentucky, October 28.

Claim.—"Having thus fully described my invention, what I claim therein as new is, in combination with receiving, distributing, and inking rollers, arranged as herein described, the adjustable ink trough, provided with removable partitions and perforated side, so as to give out the ink in lines, or belts, corresponding with the lines or size of the type in the form, for the purpose herein described."

72. For an *Improvement in the use of Steam to make Zinc White;* Henry W. Adams, Boston, Massachusetts, October 28.

Claim.—"Having thus fully described the nature of my invention, and some of the means by which the same may be put into practical use, what I claim therein as new is, mixing the vapor or gases of water or steam, with the heated vapor or zinc, or of its ores, as set forth, for the purpose of manufacturing zinc white for commercial uses.

"I also claim, in combination with the process for manufacturing zinc white, substantially as herein described, the making of hydrogen gas, for light, heat, or motive power, as herein fully set forth."

73. For an *Improvement in Baby Jumpers;* Euclid Rice, Elizabethtown, New Jersey, October 28.

Claim.—"I do not claim the use of spring, or the means of giving motion for the purpose of exercise or amusement, as that has been before employed in a variety of ways; but I do claim the combining of springs, with a frame and seat, in the manner described, forming an apparatus for teaching children to stand and walk, and at the same time to prevent the child from bearing its whole weight upon its feet, as it sits upon the seat or saddle, and can, at its option, either stand upon its feet or sit down, and at the same time move itself in any direction with its feet, and its body securely sustained in an upright position, after the upper top is locked around its waist, in the manner described, and it can, at its option, either move by a motion of its limbs, or use the machine as a jumper for amusement, as the accompanying description and drawing represent."

74. For an *Improvement in Apparatus for Watering Cattle;* S. W. Wood, Rochester, New York, October 28.

Claim.—"Having thus fully described my invention, what I claim therein as new is, in combination with a pump, worked by an endless chain of elastic balls, and operated upon by the weight of cattle, the spiral spring operating between a stationary collar and the movable cogged and threaded sleeve, for the purpose of more certainly running the sleeve into gear when the cattle step upon the platform, and for gradually stopping the platform as it rises, and the buckets as they run back into the stock or pipe, for the purpose of carrying back the water, as herein fully described and represented."

75. For an *Improvement in Threshing and Separating Grain;* Cyrus Roberts and John Cox, Belleville, Illinois, October 28.

Claim.—"What we claim as our invention is, 1st, the method herein described, of constructing threshing cylinders with curved knives, or otherwise shaped in the end, for the purposes herein described.

"2d, Also the method already described, of working the separater, by means of the jumping wheels and concave tracked brackets, or by any modification of it, whereby the action is substantially the same."

RE-ISSUES FOR OCTOBER, 1851.

1. For an *Improvement in Reaping Machines;* Wm. F. Ketchum, Buffalo, New York patented July 10, 1847; re-issued October 21, 1851.

Claim.—"Having thus fully described my invention, what I claim therein as new is, 1st, the crooked arm or coupling piece, in connexion and combination with the rack piece, and the attaching and securing the crooked arm, (supporting and sustaining the rack piece to the frame,) at or about the centre, so as to produce a balance, by securing it at such a point on either side of the centre of the driving wheel, as shall secure the balance and give firmness to the rack piece.

"2d, I claim the endless chain cutter, in combination with the pulleys and rack teeth, for cutting grain and grass, as above set forth."

DESIGNS FOR OCTOBER, 1851.

1. For a *Design for Stoves;* Lyman Cobb, Akron, Ohio, October 14.

Claim.—"Having thus distinctly represented and described the nature and arrangement of the respective ornaments and figures upon the front and hearth plates of my Franklin stove, what I claim therein as new is, the design, configuration, and arrangement of the said ornaments, as herein designated and represented."

2. For a *Design for Stoves;* Charles J. Woolson, Cleveland, Ohio, October 14.

Claim.—"What I claim as my invention is, the ornamental design and general configuration of the parts of my stove, as herein designated and represented."

3. For a *Design for Cast Iron Fences;* John T. Davy, Troy, New York, October 21.

Claim.—"What I claim is, the design and configuration of ornamental iron fence railing, substantially the same as described and represented in the annexed drawings."

4. For a *Design for Stoves;* William Savery, City of New York, October 21.

Claim.—"What I claim as original is, the design and configuration of the several ornamental figures on the front and side plates and doors of a certain stove, as represented in the annexed drawings and as above described."

5. For a *Design for Stoves;* Ezra Ripley, Troy, Assignor to Chollar, Sage, & Dunham, West Troy, New York, October 28.

Claim.—"What I claim as new is, the design of ornament and configuration of cook stove, substantially the same as herein described and represented."

NOVEMBER.

1. For an *Improvement in Air Engines;* John Ericsson, City of New York, November 4; patented in England, December 26, 1850.*

Claim.—"What I claim as my invention is, the working cylinder and piston, and the supply cylinder, and piston of less piston surface; the two pistons being connected with each other and working together substantially as specified, in combination with the regenerator and heater, so that the air or other circulating medium shall pass from the supply cylinder to the working cylinder, through the regenerator, substantially as specified, and give motion to the engine, through the difference of area of the pistons; and this I claim, whether the air or other circulating medium be made to pass on the return stroke from the regenerator to the supply cylinder, or any other receiver, or into the atmosphere.

"I also claim in connexion with the working cylinder, the employment of two regenerators, substantially as specified, in combination with the valves or their equivalents, for the purpose of causing the air or other circulating medium to pass, during a series of strokes, through one of the regenerators to the working cylinder, and back from the working cylinder through the other regenerators, and then reversing the action, substantially as specified.

"I also claim interposing the heater between the regenerator and the working cylinder, substantially as specified, to heat the air or other circulating medium, as it passes from the regenerator to the working cylinder, as specified, to supply the heat required.

"And finally, I claim communicating the power of the engine to the working beam, or its equivalent, by the attachment thereof, to one of the pistons, or piston rods, between the open ends of the two cylinders, said pistons being connected or braced to each other, substantially as specified, whereby I am enabled to render the engine compact, and effectually to brace and connect the two pistons, and avoid undue strain, as specified."

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* See page 228.

2. For an *Improvement in Machines for Forming Horse Collars;* Isaac Davis, Mechanicsburgh, Ohio, November 4.

Claim.—"What I claim as my invention is, the combination of the moving tapering block with the adjustable stationary dies, the two being constructed and arranged substantially as herein set forth."

3. For an *Improvement in Cultivators;* Isaac Constant, Buffalo Heart Grove, Illinois, November 4.

Claim.—"What I claim is, the intermediate jointed ploughs, in combination with the main cultivating ploughs as described, for enabling the ploughman to plough nearer to or further from the rows, at will."

4. For an *Improvement in Seed Planters;* Newton Foster, Gilbert Jessup, Hiram L. Brown, and Calvin P. Brown, Palmyra, New York, November 4.

Claim.—"Having thus described the nature and operation of our invention, what we claim as new is, in combination with the seed box and cap, arranging the rotating disk vertically, and providing it with projections, and the stationary vertical dies provided with an opening for receiving the grain, and the flanches between which the said projections rotate, and by which the grain is carried from the seed box to the cap, and thence to the seeding tube; the whole being arranged in the manner and for the purpose specially set forth and described."

5. For a *Machine for Measuring and Cutting Iron;* Levi B. Griffith, Honeybrook, Pennsylvania, November 4.

Claim.—"What I claim as my invention is, the measuring wheel, placed in any suitable position, in combination with the cutter, bed plate, and spring, or its equivalent; the whole being arranged and combined, substantially as described, for the purpose herein set forth."

6. For an *Improvement in Desks;* John T. Hammitt, Philadelphia, Pennsylvania, November 4.

Claim.—"Having thus fully described the construction and operation of my elevating desk, what I claim as new and of my invention is, the raising of a horizontal surface at the back part of the desk or table, when the front part is being raised to form an inclined plane, by means of the arrangement of the screw and lever, or any analogous device, the front part being hinged to the elevating frame, the same to be applied to standing or sitting desks or tables, substantially in the manner and for the purpose set forth."

7. For an *Improvement in Radiating Surfaces;* Joshua K. Ingalls, Bushwick, New York, November 4.

Claim.—"What I claim is, the application of the tapering form to radiating surfaces, constructed in the compact and available manner above described."

8. For an *Improvement in Tanners' Oil from Resin;* Louis S. Robbins, City of New York, November 4.

Claim.—"What I claim as my invention is, the new and original product or manufacture which I denominate Robbins' tanners' oil, or Robbins' curriers' oil, the process of producing which I herein fully set forth; I also claim every use and application of my said oil."

9. For an *Improvement in Lubricating Oil from Rosin;* Louis S. Robbins, City of New York, November 4.

Claim.—"What I claim as my invention is, the new and original product, or manufacture which I denominate Robbins' lubricating oil, the process of producing which I have herein fully set forth.

"I also claim every use and application of the said oil."

10. For an *Improvement in Distilling Naphtha from Rosin;* Louis S. Robbins, City of New York, November 4.

Claim.—"Having thus fully described my new and improved process of distilling rosin, what I claim therein as my invention is, 1st, the process of separating the acid and water arising from the decomposition of rosin, at the temperature of 325 degrees Fahrenheit, or thereabout, by means of fire heat, substantially in the manner herein set forth.

"I also claim, in combination with the above, the process of separating the naphtha from the other component parts of the rosin, by preserving the temperature of the liquid mass within the still at about the range of 325 degrees Fahrenheit, as above stated, and injecting steam into the same; by which I am enabled to throw off the naphtha at the same temperature employed for throwing off the acid.

"I do not intend to limit my improved process of distillation, as herein before described, to the production of oil from rosin, but shall employ it for redistilling the crude article known as rosin oil."

11. For an *Improvement in Paint Oil from Rosin;* Louis S. Robbins, City of New York, November 4.

Claim.—"What I claim as my invention is, the new and original product of manufacture which I denominate Robbins' paint oil, the process of producing which I have herein fully set forth.

"I also claim every use and application of my said oil."

12. For an *Improvement in the Manufacture of Charcoal;* Wm. P. McConnell, Washington, District of Columbia, November 4.

Claim.—"What I claim as my invention is, the iron cylinder with a double bottom, the upper one being perforated, and these combined with several flues covered at the top with dampers, and protected within with iron rings, the whole so constructed that the fire may be applied either on the top, under the bottom, or within the flues, or in all together at pleasure; and the whole adapted as herein described to the uses and purposes specified, and these only."

13. For an *Improvement in Folding Doors of Stoves;* James Root, Cincinnati, Ohio, November 4.

Claim.—"Having thus fully described my improved doors for grates and stoves, what I claim therein as new is, the sliding and folding doors, in combination with pilasters, by which I prevent the heating of the doors and warping consequent thereon, and admit a free radiation of heat from the side of the stove, substantially in the manner and for the purposes set forth."

14. For an *Improvement in Processes for Dyeing Blue;* Edward Swiney, Andover, Massachusetts, November 4.

Claim.—"I claim as my invention, the mode of producing a dark blue, or color, to take the place of indigo, which color can be produced at a very great saving of expense in comparison to that incurred by the employment of indigo in the usual way.

"I do not mean to claim the use of a prussiate of potash dye alone, but do claim the employment of such dye, in combination with either one or more of the above named woods, substantially in manner as specified."

15. For an *Improvement in Compounds for Extinguishing Fires;* Joshua Upham, Salem, Massachusetts, November 4.

Claim.—"I am aware that it is known that sulphurous acid gas will extinguish the flame of a taper or any such like small flame; I therefore do not claim such as my invention; but what I do claim is, the application of a compound of sulphur and nitre in a state of combustion, within a room or apartment on fire, for the purpose of extinguishing the fire tending to destroy the said room or building thereof."

16. For an *Improvement in Springs;* James Webster, Leicester, England, November 4; patented in England, February 11, 1851.

Claim.—"Having described the nature of my said invention and the manner of performing the same, I declare that I claim as my invention, the above specified mode of arranging or combining springs and inclined planes or surfaces, curved or plane, so that the points or arms of the springs may be applied to, or press against the inclines, or inclined planes, for the purpose of thereby obtaining the action of such springs, in manner hereinbefore described."

17. For *Improvements in Planing Machines;* Geo. W. Beardslee, Albany, New York, November 4.

"The nature of my invention consists in the application of springs, or weights, to each edge and end of cutter stocks, on which knives with caps are bolted, for the planing of boards or plank, whereby they are caused to yield both on the heel and edge."

Claim.—"Having thus fully described the nature of my invention, what I claim therein as new is, the application of springs or weights to cutter stocks, both at their point in line with the cutting edge of the knife, and also to the heel, by which a double action is given to the stock, both at the heel and edge, allowing it to rise and oscillate to the inequalities of boards or plank, substantially as described and for the purposes herein set forth."

18. For an *Improvement in Carriage Springs;* Levi Bissell, City of New York, Assignor to himself and Lyman Kinsley, Canton, Massachusetts, November 4.

Claim.—"My improvement, and therefore what I claim, consists in combining buttress blocks, with the wood bar, and the metallic strap bar, in such manner, substantially as specified, so that such blocks, when the spring is in use, shall act as levers to compress the wood and counteract the tendency of the fibres to be elongated and ruptured by the downward strain."

19. For an *Improvement in Machines for Dressing Staves;* Lewis S. Chichester, Williamsburgh, New York, November 4.

Claim.—"What I claim as my invention is, dressing staves by means of stationary knives, in combination with a pressure roller directly over the cut, when this is combined with the bed, constructed with a raised portion when the cutting is done, for the purpose of allowing a crooked or bent stave freedom of motion while being dressed, substantially as described."

20. For an *Improvement in Bating and Tanning Hides;* Wm. B. Milligan, Edinburgh, Virginia, November 4.

Claim.—"What I claim as my invention is, the method herein described, of bating hides and other skins in the process of tanning, by subjecting them to a vapor bath applied substantially in the manner herein described.

"I also claim the combination of the rocking frame and the shaft above, the two being connected as herein set forth, in such manner that the shaft may be used either to rock the frame or to raise it from the vat."

LAW REPORTS OF PATENT CASES.

French, et. al., *vs.* Rogers, et. als.

Morse and Bain Telegraph Controversy, tried in the Circuit Court of the United States for the Eastern District of Pennsylvania, during the month of September, 1851.

Reported for the Journal of the Franklin Institute.

This cause was commenced by a bill in Equity, filed on the 12th of July, 1850, in behalf of B. B. French and others, as trustees of the Magnetic Telegraph Company. This Company are vested, by assignments from Professor Morse, with the exclusive right to use his inventions and improvements in telegraphing on the line between the cities of New York and Washington.

Professor Morse had obtained three patents from this Government for his several improvements.

The first and principal one of these patents was issued to Prof. Morse on the 20th of June, 1840, and was corrected by two subsequent re-issues. This patent, it was alleged in the bill of the complainants, secured to Morse and his assignees, among other things,

I. The exclusive use of Electro-Magnetism for *recording* intelligence at a distance.

II. The exclusive use of a system of signs, composed of dots and lines, for telegraphing.

III. The exclusive use of combined galvanic circuits for telegraphing.

Professor Morse's second patent was issued April, 11, 1846, and was afterwards re-issued in a corrected form. This patent, it was alleged in the bill of complainants, secured to Morse and his assignees, the exclusive right to use a peculiar adjustable device, called by Morse a receiving magnet, to combine together a long telegraphic circuit and one or several short telegraphic circuits.

The third patent of Prof. Morse, it was alleged, secured to him and his assignees the exclusive right to record the system of dots and lines of his first patent by means of simple chemical decomposition.

The complainants' bill further stated that the respondents had erected a line of telegraph, on which they employed the agency of electro-magnetism for recording at a distance, and that they used the same system of signs Morse had patented,—the same combination of receiving magnet and local circuits,—and that they had recorded Morse's signs by chemical decomposition. That by so doing, they infringed upon complainants' rights as assignees of the three above named patents of Prof. Morse.

The complainants' bill prayed for the usual remedy by writ of injunction, and that the respondents be ordered to account to the complainants for the profits which they have derived by their infringement.

The respondents filed on the 25th of September, 1850, an answer to the above bill of complaint, and stated, among other things, that Morse was not the inventor of the several things claimed by him. That Prof. Henry, of Princeton, had preceded him in some material part, if not all, of his invention in regard to the employment of electro-magnetism for recording at a distance, by a publication in the 19th volume of Silliman's Journal, and by statements to his class at Princeton College.

It was alleged that Harrison Gray Dyar had erected a recording telegraph on Long Island in 1827, and had used substantially the same system of signs as Morse has patented.

That the same system of signs was described in a book called the "Mural Diagraph," published by James Swain, at Philadelphia, in 1829.

That the telegraph of Gauss & Weber, of Gottingen, that of Schilling, and that of Cooke & Wheatstone, of England, involved substantially the same use of electro-magnetism, and that these were anterior in point of date to Prof. Morse's invention, or to the issuing of his patent.

That Steinheil had invented a recording telegraph, using electro-magnetism, and that a description of this invention was published in September, 1838, and defeated Prof. Morse's right to a patent for the exclusive use of electro-magnetism for recording at a distance.

That Dr. C. T. Jackson, of Boston, during a voyage on board the "Sully," from France, in 1832, had invented the art and mechanical means of telegraphing patented by Morse, and communicated these to Morse.

That Messrs. Cooke & Wheatstone, and Charles Davy, of England, had preceded Morse in the invention of combined circuits for telegraphing generally, and in the employment of a receiving magnet to connect a long circuit to one or more local circuits.

That Prof. Henry had also preceded Morse in the invention of combined circuits for telegraphing, and in that of the receiving magnet and local circuit arrangement of Morse's second patent.

The respondents alleged that Alexander Bain and others had preceded Morse in recording the dot and line alphabet by chemical decomposition, as described in Morse's chemical patent.

The respondents further said that they did not infringe either of Prof. Morse's patents; that they used what they called a branch circuit, which was a new invention of H. J. Rogers', different from Morse's local circuit; and that they had so modified their system of signs as to make it entirely different from Morse's system, and no infringement, and that their use of electro-magnetism was not an infringement.

The respondents also set forth that Prof. Morse's original patent was invalid, because the Commissioner of Patents had not made it to bear date from the date of a French patent which Morse had taken out for the same invention before his American patent was issued.

The complainants denied that any one was prior to Morse in the invention of the things claimed by him, and denied that he had derived any material part of them from any other person, and controverted all the matters of law and fact alleged by the respondents.

The foregoing were the principal questions raised by the bill and answer. There were also some secondary questions as to the identity of the original patents and the re-issues,—the patentability of certain claims, and the sufficiency of description of certain portions of these patents.

Notice was given by the complainants in July, 1850, that an application would be made in the ensuing September for an interlocutory injunction. This application was not then pressed, but a day was fixed for final hearing, and the respective counsel and parties commenced taking testimony in support of their several positions. The taking of the testimony in this case consumed nearly six months, and occupied over 1000 closely printed pages. On behalf of the complainants, there were examined Professors Byrne, Barrett, Chilton, Renwick, and Chester, of New York; Professors Frazer, Tilghman, and Wetherill, of Philadelphia, and Gale and Page, of Washington. And on behalf of the respondents, Professors Henry, Walker, Mathiot, Keith, and Benedict, of Washington; Jackson, Channing, Horsford, Hayes, and Gould, of Boston; Ellet, Gibbs, and McFarlane, of New York, and Henry D. and James B. Rogers, of Philadelphia.

Harrison Gray Dyar was examined as to his telegraph on Long Island.

The case came up for final hearing before Judges Grier and Kane, on the 15th of September last, and was argued by Messrs. Campbell, Kendall, Gifford, and Harding, for the complainants, and Messrs. Meredith, Gillette, McCall, and Schley, for respondents.

In addition to the points set out in the bill, it was contended, in argument on behalf of the complainants, that the law requires only that the re-issued patent should be for the same invention for which the original patent was granted, and not that the original and re-issued specifications or claims must be identical; citing Sloat *v.* Spring, et al.; Woodworth *v.* Wilson; Allen *v.* Blunt; 3 Story, 749, and others.

That an "art" is patentable under our patent laws, as well as a mechanical instrument or combination; citing Whittemore *v.* Cutter, 1 Gall. 498; Crane *v.* Price, Webster's P. C., 409; Parker *v.* Hulme, and other cases. That he who discovers a principle and devises one mode, by which the same can be rendered practically useful, is entitled to protection against all other devices for using that principle.

It was contended on behalf of the respondents, that printed publications of any matter or thing claimed in Morse's patent, made prior to the date of his *application*, render his patent invalid. That Morse's re-issued patents were void because the claims were varied from those of the original patents. That a patentee cannot cover all modes of using a power or result, but is confined to the particular mode invented by him. Stone *v.* Sprague, 1 Story, 270, and other cases.

When a patent is for a combination of parts, and not for the different parts composing the combination, the use of any parts less than the whole is not an infringement. Barrett *v.* Hall, 1 Mason, 447, and other cases.

An invention is not complete so as to be patentable, or to bar the obtaining a patent by another inventor, until it is perfect and adapted to use. Reed *v.* Cutter, 1 Story, 590, and other cases.

The argument occupied the undivided attention of the Court for several weeks. In the course of the argument numerous drawings, working models, and experiments, illustrative of the inventions of Prof. Morse, the telegraph of the respondents, and the principles of science involved in the contest, were exhibited on behalf of the respective parties. The questions of law raised were elaborately argued, and a large mass of authorities discussed.

On the 3d of November, Judge Kane delivered the opinion of the Court, Judge Grier expressing his full concurrence therein.

OPINION OF THE COURT.

This case is before us on final hearing upon the pleadings and proofs. Professor Morse, under whom the complainants hold, has three patents: the first, dated 20th June, 1840, re-issued after surrender on the 25th January, 1846, and again re-issued after a second surrender on the 13th June, 1848, which has been referred to in the argument as the Magnetic Telegraph Patent; the second, dated 11th April, 1846, also re-issued on the 13th June, 1848, referred to as the Local Circuit Patent; the third, dated 1st May, 1849, referred to as the Chemical Patent. The Bill charges that the respondents have infringed all three of these patents: the answer denies the infringements, and controverts the validity of the patents.

I. The objections to the validity of the first patent, that for the Magnetic Telegraph, are stated in the defendants' brief, as follows:

"I. That it does not run from the date of Morse's French patent.

"II. That the Commissioner of Patents had no authority in law to re-issue a second time.

"III. That the claims set out in the first re-issue are broader than the claims in the original patent; and the claims in the second re-issue are broader than those of either of its predecessors, and are not for the same invention."

1. The first of these objections founds itself upon the fact, that Mr. Morse had obtained a patent in France for this same invention twenty-two months before his patent issued here; and it asserts, that under the second proviso of the 6th Section of the Act of 1839, his American patent should in consequence have been limited to the term of fourteen years from the date of the French patent; and that not having been so limited, it is void.

This objection was fully met in the argument of the complainants. Mr. Morse's application for a patent in this country was made in April, 1838, and was filed and acted on in the Patent Office before the 10th of that month; his French patent bears date the 18th of August following. There is therefore no room for the questions, which were argued so elaborately, of the proper interpretation of this proviso in the 6th Section of the Act of 1839, and the 8th Section, second clause, of the Act of 1836, which was also invoked, in any possible bearing upon the case of Mr. Morse. The proviso of 1839 must be interpreted by reference to the enacting words of the section which it limits; and the provisions of both the sections relate only to such patents as are *applied for* here, after the issue of a foreign patent. But Mr. Morse's application here was before his patent abroad—in nowise after it;—and his American patent was granted therefore under the general enactments of the Act of 1836, not under any special proviso or exception whatever; and its term runs properly from its date.

We do not see the justice of the criticisms upon his application, that the jurat affixed to it is without date of day or month; and that the drawings, which accompanied it, were not in duplicate. There is no act that requires the jurat to be dated at all; and the supplementary provision of the 6th Section of the Act of 1837, that "the applicant shall be held to furnish duplicate drawings," though directory in its terms, is not a condition; and it has obvious reference in point of time to the issuing of the patent, and not to the filing of the petition for it. Such has heretofore been the interpretation of the Patent Office, announced in the official circulars for the instruction and guidance of inventors; the practice founded on it is both reasonable and convenient; and no Act of Congress appears to conflict with it. If Mr. Morse's patent is invalid on this ground, more than half the modern patents for mechanical inventions must probably fall with it.

2. The second objection to the patent is, that the Act of Congress makes no provision for a second surrender and re-issue.

The 13th Section of the Act of 1836, which provides in certain cases for the surrender of a defective patent, and its re-issue in an amended form, regards the new patent as substituted for the old one, with just the "same effect and operation in law" as if the specification had been filed at first in the form which it takes in the re-issue. It is difficult to see why, if the original patent could be amended, its substitute, having all the legal attributes of the original, cannot be amended also.

There is nothing in the words of the act, or in the policy which it proclaims, that limits the correction of errors to such as may have been the first discovered. On the contrary, if it be true, as we have supposed in determining the recent case of Battin *vs.* Taggert, that the patent is granted to the inventor in consideration of some benefit to be derived by the public from his disclosures, and that the re-issue is in consideration of some more full or more accurate disclosure than that which he had made in his original specification, or some renunciation on his part of an apparently secured right,—it is for the public interest, that the surrender and re-issue should be allowed to follow each other, just as often as the patentee is content to be more specific or more modest in his claims.

Besides, it might not be safe to assume too readily, that the act was intended to withdraw altogether from the officers of the executive department the power, which they had before, to accept a surrender and grant a re-issue, and which would sanction a second re-issue quite as readily as a first. The act might perhaps be regarded more justly as affirming the propriety of the usage which had obtained under the former laws, and had been repeatedly recognized by the Courts, (Morris *vs.* Huntington, 1 Pain. 355-6; Grant *vs.* Raymond, 6 Pet. 220; Shaw *vs.* Cooper, 7 Pet. 315,) and as prescribing in addition the conditions and incidents which should attach to it thereafter in certain cases. It is hardly to be supposed that the merely clerical error of an engrossing subordinate, or the accidental inadvertence of the Commissioner himself, is not capable of being rectified or supplied now, just as it was before the passage of the act. And yet the construction, which regards this section as superseding the implied power of the Commissioner, might lead to this, since the act makes no provision for correcting such mistakes on the part of the patent officers.

Still further: it must, as we think, be conceded, that if the Commissioner's power to re-issue, is so restricted by the Act, as to be exhausted by a single exercise, his power to accept the surrender must be equally restricted, and equally transitory. And the argument then resolves itself only into another form of the question, whether the patent was for any purpose a valid one as it stood after the first re-issue; because, if the second re-issue was invalid for want of authority to make it, the second surrender was ineffective for want of authority to accept it—and so the patent stands as if it had not been surrendered the second time. The surrender and the re-issue, no matter how often they recur, are reciprocal—each in consideration of the other—and forming together but a single act between the parties. It would be unconscientious to retain the consideration, while denying the validity of the grant. See Woodworth *vs.* Hall, 1 Wood C. & M. 400.

3. We pass to the third objection, the supposed variance in the re-issues.

From the course of some parts of the argument on this point, it might be inferred that the objects as well as the import of the 13th Section of the Act of 1836 had been misapprehended by the learned counsel for the respondents. It is not the meaning of the law, that the patentee who applies for a re-issue, must at his peril describe and claim in his new specification, either in words or idea, just what was described and claimed in his old one. His new specification must be of the same invention, and his claim cannot embrace a different subject matter from that which he sought to patent originally. But, unless we narrow down the correction which the statute contemplates, till it becomes a mere *disclaimer*, it is not possible in any case to frame a corrected specification, which shall not be broader than the one originally filed. To supply a defect, to repair an insufficiency, is to add—either directly or by modifying or striking out a limitation:—in either form, the effect is to amplify the proposition,—in the case of a specification under the patent laws, it is to amplify the description and enlarge the claim.

There are few things more difficult, even for well educated and practised lawyers, than to describe a new invention clearly, and point out the principle which distinguishes the subject of it from all things known before:—And as inventors are rarely experts either in philology or law, it has long been established as a rule, that their writings are to be scanned with a good degree of charity. But it is easy to abuse this liberality to the purposes of fraud. The public has rights to be guarded also; and these exact, that the patentee's specification shall set forth his invention so fully and definitely that it cannot be readily misunderstood.

It is the purpose of the statute, to reconcile this seeming conflict; and it effects it by allowing the inventor to amend the mistakes he has honestly fallen into in his description and claim of title, as soon and as often as he discovers them. And there is the more reason for this indulgence, since under the act of 1836, sec. 7, the specification is reviewed by the Commissioner before the patent issues, and is very often modified in accordance with his suggestions, or to obviate objections made by him to its original form. He may be supposed to know, therefore, better than any one else but the patentee himself, what the invention was for which the patent was sought at first, and he may also know whose inadvertence, accident, or mistake it was, that made the first specification inoperative or invalid. It is not absolutely impossible that it may have been his own; as certainly it had his implied concurrence.

And this consideration furnishes a strong argument for the rule, that the Commissioner's action in ordinary cases of re-issue shall have more than a *prima facie* influence in finally deciding the question of identity of invention. Whatever be the extent of that rule; whether it leaves nothing open for discussion before the Court, but the issue of fraud; as appears to have been the undivided opinion of the Supreme Court, in the case of Stimpson, 4 How. 404; or whether we permit ourselves to except from it, as we did in Battin *vs.* Taggert, cases in which the invention claimed in the re-issued patent is obviously different from that claimed in the original; or whether, with Judge Story, in Allen *vs.* Blunt, 3 Stor. 740, and in Woodworth *vs.* Stone, *ibid.* 749, we hold the grant of the amended patent to be "conclusive as to the existence of all the facts, which by law are necessary to entitle the Commissioner to issue it; at least, unless it is apparent, on the face of the instrument itself, without any auxiliary evidence, that he was guilty of an excess of authority, or that the patent was procured by a fraud between him and the patentee." Whatever be the rule, or its limitations, the propriety of the re-issue in the case before us can hardly claim a judicial review. There is no want of jurisdiction, either apparent on the face of the proceedings or asserted by the evidence; and there is no fraud imputed, or justly imputable.

Nor is there any flagrant diversity of claim. After a repeated and careful examination of the three specifications, with their respective claims, fully aided by the acumen of highly ingenious counsel, we have not found a material difference of import between any of them. The order in which the subjects of claim are marshalled is not the same throughout; a phrase is more concise in one, in another more popular; in one a scientific term, or a general expression, takes the place of the descriptive or defining language, or the detailed particulars of another; in a word, they are unequal as specimens of artistic writing, and a close examination may detect defects in the two first, which are repaired in the last. But they all describe the same thing essentially; and we should find it easier to argue, that neither the first nor the second specification could be rightfully regarded as "inoperative or invalid" for want of precision and clearness than that there was an important variance in the second from the first, or in the third from either.

These observations form the answer to the third objection.

Mr. Morse's patent of 1840, in all its changes, asserts his title to two distinct patentable subjects; the first, founded on the discovery of a new art; the second, on the invention of the means of practising it.

1. That he was the first to devise and practise the art of recording language, at telegraphic distances, by the dynamic force of the electro-magnet; or, indeed, by any agency whatever, is, to our minds, plain upon all the evidence. It is unnecessary to review the testimony for the purpose of showing this. His application for a patent, in April, 1838, was preceded by a series of experiments, results, illustrations, and proofs of final success, which leave no doubt whatever but that his great invention was consummated before the early spring of 1837. There is no one person, whose invention has been spoken of by any witness or referred to in any book, as involving the principle of Mr. Morse's discovery, but must yield precedence of date to this. Neither Steinheil, nor Cook and Wheatstone, nor Davy, nor Dyar, nor Henry, had at this time made a recording telegraph of any sort. The devices then known, were merely *semaphores*, that spoke to the eye for the moment—bearing about the same relation to the great discovery now before us, as the Abbe Sicard's invention of a visual alphabet for the purposes of conversation bore to the art

of printing with movable types. Mr. Dyar's had no recording apparatus, as he expressly tells us; and Professor Henry had contented himself with the abundant honors of his laboratory and lecture rooms.

When, therefore, Mr. Morse claimed, in his first specification, "the application of electro magnets" "for transmitting, by signs and sounds, intelligence between distant points," and "the mode and process of recording or making permanently signs of intelligence transmitted between distant points;" and when in his second specification he claimed "the making use of the motive power of magnetism, when developed by the action of currents of electricity, as a means of operating and giving motion to machinery, which may be used to imprint signals upon paper or other suitable material," "for the purpose of telegraphic communication;" characterising his "invention as the first recording or printing telegraph by means of electro-magnetism;" and when, in his third, after again describing his machinery and process, he once more characterised it in the same terms, and claimed "as the essence of his invention the use of the motive power of the electric or galvanic current, (electro-magnetism as he now terms it,) however developed, for marking or printing intelligible characters, signs of letters at any distance;" through these several forms of specification, claiming and renewing his claim of property in the same invention, as it seems to us—and claiming in each and all of them no more, as it also seems to us, than he was justly entitled to claim,—he declared the existence of a new Art, asserted his right in it as its inventor and owner, and announcing fully its nature and elements, invoked in return the contracted protection of the Laws.

From this time his title was vested as patentee of the art, and other men became competitors with him only in the work of diversifying and perfecting his details. He himself used the *stylus*, to impress paper or parchment, or wax coated tablets, it may be; though he sometimes made a colored record by the friction of a pencil: another substitutes a liquid pigment, or stains his paper with a chemical ink: the next perhaps stains his paper beforehand, and writes on it by decomposing the coloring matter: and another yet more studious of originality than the rest, writes in a cyclovolute, instead of a straight line, and manufactures his ink as he goes along, by decomposing the tip of his stylus on a chemically moistened paper. They are no doubt all of them inventors; as was the man who first cast types in a mould, or first bent metal into the practical semblance of the gray goose quill, or first devised sympathetic ink, that the curious in letter writing might veil their secrets from the profane. All these toiled ingeniously and well, to advance and embellish a pre-existing art. But they had no share in the discovery of the art itself, and can no more claim to share the property, which its discovery may have conferred on another, than he who has devised some appropriate setting for a gem, can assert an interest in the gem itself.

Yet admitting, for the sake of argument, that Mr. Morse's leading invention is correctly designated as a new art; and that he has sought to patent it accordingly, by a compliance with all the requisitions of the statute—it is still contended, and with much of elegant research into the radical meaning of the term, that an art, as such, cannot be made the subject of a patent. But interpreting language as men use it around us and as it reflects ideas, the question can hardly be regarded as doubtful. The constitutional provision, under which our patent laws are framed, looks to the promotion of "useful arts." The Act of Congress places "a new and useful art" among the discoveries it professses to protect, and assigns to it the first place on the list. The statute of 21 James I, c. 3, from which the patent system of England has grown up, speaks only of "new manufactures:" Yet the Judges of that kingdom find a warrant in this limited expression for sustaining patents for an art, and even for the renewed discovery of an art that had been lost. (See the Hot Blast case, *Webster P. C.* 683, 717, and Mr. Webster's note at p. 718, and the case of Wright's patent, *ibid.* 736, and the cases grouped in Hindmarch, pp. 77-102.)

Indeed, the author whose treatise we have cited last, asserts with much emphasis, that it is the art, and nothing else, which is the characteristic subject of every privilege granted by a patent under the statute: *p.* 92. And it may be noted, as not without interest, that in just accordance with the spirit of the English law cases, the English patents of Cooke and Wheatstone, Davy, and Bain, claim property in the arts for which their mechanical devices are respectively adapted; not, indeed, in so many words, but in language as unequivocal as that employed by Mr. Morse.

Nor can we see that there is any reason of policy, which should deny protection to an art, while extending it to the machinery or processes, which the art teaches, employs, and makes useful. Why should the type, or the inkball, or the press itself, be dignified beyond the art, to which they minister in such humble subordination, and without which they are rubbish? Will you patent the new product, and the new elemental means, and the new process by which they act, and then debate whether you may patent the art? You have patented it already.

We are aware, of course, that it has been held in some cases under the English patent law, that the art to be patented must have some reference to a manufacture. (See Hindmarch, *ut supra.*) But while such a deduction might be legitimate from the words of the statute of James, it would be obviously otherwise under the more liberal phraseology of our Act of Congress. And even in England, it must be apparent to every one who has watched the progress of their patent system, that this limitation is practically disregarded already, and that it is to be repudiated as soon as it shall interfere with the protection of an important invention.

Yet, in truth, there are few discoveries of practical moment to the daily concerns of men, even in the lapse of many years, that are not more or less directly connected with some department of manufacturing industry or skill. The convex lens—the steamboat—the iron road, on which cars are propelled by the friction of driving wheels—some of these may be so indirectly connected with manufactures, or rather they are associated so intimately with the leading pursuits and interests and enjoyments of all of us, to make it difficult to refer them to the category of a particular manufacture. Would it not be strange if, on this account, they were excluded from the benefits of the patent system? If we go back to the early story of our race, and mark the stages of its long and difficult advance,—from language, the first exponent of thought, to letters, its first record,—and from letters to printing, which first diffused letters, widely though slowly, among men,—and from printing, to the telegraph, the electric register of thought, spreading its fibres of sympathy over the intelligent world, and making it throb simultaneously everywhere, as with the pulsations of one heart;—who will say that each transition between these great epochs, that signalize the moral and intellectual progress of mankind, should not be marked by a memorial as stately, as the first clipping of a cut nail, or the compounding of a new variety of liquid blacking? or that the men, to whom we owe them, should not be dealt with as liberally, or at least as justly, by the State?

2. The second general subject of Mr. Morse's patent of 1840 includes many particulars; all of them interesting and valuable in connexion with the claim we have just been considering. Taken together, they give a practical form to his leading invention, and guard it from the imputation of being a mere abstract notion, a principle resting in idea. Taken singly, some of them appear to us to be new; as his alphabet (*claim* 5); his combined series (*claim* 4), by which the electric current from one battery, before entirely expending itself in its lengthened circuit, is made to set another battery in action, from which another circuit traverses to a battery still beyond,—and so onwards; his adaptation of clock-work to the recording cylinders, (*claim* 2):—others again are only new, as they are elements of a novel combination. There is no proof before us, that any of the devices, which Mr. Morse has claimed in this patent, whether as independent inventions or parts of a combination, are not really his so far as he has claimed them. It is unnecessary to discuss them in detail, for they are all substantially protected, as appliances of the Art, which is the great subject of his patent.

II. The second patent of Mr. Morse is for what has been termed his Local Circuit. To understand the questions which arise upon this, it is necessary to refer back to the apparatus which he had patented before, and to explain in general terms its principle and modes of operation. I shall attempt to do this in popular language, and without stopping to consider very carefully the varying niceties of scientific nomenclature.

It is well known that a current of galvanic electricity, while passing along a wire that has been wound spirally round a bar of soft iron, communicates to the iron a certain degree of magnetic virtue, and that the iron loses this magnetic character again as soon as the electricity ceases to pass along the wire that surrounds it. It is also well known that the electric fluid may be passed along a wire of great length, and yet retain even at the farthest extremity of the wire a sufficient degree of energy to impart this occasional magnetism to the iron, and to make it capable for the time of attracting any small body of iron that may be near it. If such a small body of iron be made to form the extremity of a nicely balanced lever, it is plain that while the one extremity of the lever is attracted towards the temporary magnet, the other extremity will be moved in the opposite direction; and if to this other extremity we affix a pencil or stylus, this will press upon whatever surface may be interposed in the way of its motion, and may either mark the surface, or, if it be of a yielding nature, indent it. It is plain also, that when the bar of soft iron ceases to be magnetic, in consequence of the electric fluid ceasing to pass round it, the lever will take its original position, and the stylus ceases to press upon the resisting surface.

If, now, we suppose that surface to be moved uniformly below the stylus, it is obvious that the surface will be marked with a straight line, and that this marked line will be interrupted during any intermission of the electric current, so as to form a broken series of straight lines, or if the electric current passes and intermits in rapid alternation, a series of dots or points. These broken traces of the stylus, the lines and dots, constitute the *alphabet* of Mr. Morse; a certain succession of either or a certain combination of the two being arbitrarily chosen to indicate a particular letter.

The galvanic battery generates the electric fluid continuously, whenever the two extremes or poles of the battery are connected by a suitable conducting medium—such as a metallic wire, water, or the earth itself—along which *conductor*, as it is called, the electric fluid may pass between one pole of the battery and the other, thus performing what is termed an *electric circuit.*

Let us now extend a continuous wire from one of the poles of the galvanic battery to a distant point, taking care that it shall not be intermediately in contact with the earth or with any other good conductor of electricity, and let us at the distant point pass the wire in a spiral coil round a bar of soft iron, and thence lead it back again to the other pole of the battery, or avail ourselves of the earth itself as part of the circuit. It is obvious from what we have said before, that the electric fluid, passing from the battery along the wire, around the occasional magnet, and back to the battery, and then at appropriate intervals of time interrupted in its circuit, will cause the stylus to make its trace of lines or dots, or in other words its alphabetical record, at the distant station.

It only remains then to devise a mode of interrupting and renewing at pleasure the flow of the electricity—*breaking and closing the circuit*, in the language of the experts. This is done by dividing the wire near the battery, and then arranging a simple finger key, which, when struck or pressed upon by the finger, brings a short metallic conductor into intimate contact with the two ends of the divided wire, and thus restores the continuity of the circuit while the pressure continues on the key. This may serve as a rude explanation of Mr. Morse's Electro-Magnetic Telegraph in its simplest form.

It was found, however, at an early period, that though the electric current was still appreciable after it had passed over a great length of wire, yet in traversing the very long circuits that were required to include distant telegraphic stations, it ceased to impart a sufficient degree of energy to the temporary magnet to work the stylus effectively. To meet this difficulty, Mr. Morse resorted to the simple device of employing a series of batteries distributed over his line of telegraphic communication, with as many shorter circuits, each operating, by means of a magnet at its extremity, to control the movements of a small lever, that opened or closed the circuit of the battery beyond. The last battery gave efficiency to the recording apparatus at the distant station. This formed the *combined series* of Mr. Morse's first patent.

It is easy to see, that the intermediate magnets of the combined series, besides opening and closing the circuits, might be also made to act as recording magnets, by merely adapting to them the stylus with its appendages; and that there would thus be as many stations of telegraphic communication as there were batteries and minor circuits. But there still remained this objection to the combined series, that it could only be worked in one direction, and it was necessary therefore to have two complete lines of wires, with their batteries and magnets, in order to establish a reciprocating communication.

To dispense with this duplication of machinery and expense was the object of Mr. Morse, in the invention which is the subject of his second patent. It had been found that the magnetism excited by the electric coil was capable, at the end of an almost indefinitely extended circuit, of giving motion to a delicately adjusted lever, but that this was the apparent limit of its dynamic power. A single wire might be employed then, without intervening magnets, by connecting it at the extremities with electro-magnets, of great sensibility of mechanism, and employing the force of those magnets merely to open short local circuits, from which local circuits the degree of magnetic energy adequate to the purposes of the recording apparatus could be derived.

It is found, however, that the magnetism induced in soft iron by the electric current, though truly occasional, does not absolutely cease at the instant of breaking the circuit, but seems to linger in the iron for an appreciable interval of time afterwards, with an intensity, which, though slight, bears an apparent relation to the intensity of the current that induced it. This would interfere greatly with the very rapid operation of the telegraph, if the lever were left to withdraw itself from the magnet, to which it serves as armature, by the force of gravity alone. A small compensating spring is therefore connected with the machine, of sufficient strength to overcome the attraction of this lingering or continuous magnetic force, but not sufficient to resist the attraction of the magnet when the circuit is closed.

But the electric current after passing over a long wire, does not exert a uniform dynamic energy. However carefully insulated at first, the wire becomes, after a time, more or less exposed to atmospheric action, and the fluid is more or less dissipated in consequence. The posts, on which it is supported, become conductors during storms of rain, and carry off the fluid to the earth. Under other circumstances, the electro-magnetic phenomena are exaggerated at the receiving station by atmospheric electricity from the regions through which the conducting wire has passed. The batteries too do not always generate the fluid with the same rapidity. In a word, the current at the extremity of the circuit is irregular.

Now it is apparent, that under these varying states of the magnetic energy, the adjustment of the compensating spring at the receiving station must not be uniform. If its tension were just that which would neutralize or barely overcome the continuous magnetism induced by an electric current of small intensity, it would not draw back the armature when the inducing current had been in greater force; and on the other hand, a stronger spring, adapted to the case of a powerful current, would oppose a controlling resistance to the magnetism induced by a feeble one. The *Adjustable Receiving Magnet*, described in Mr. Morse's second patent, meets perfectly the conditions of this difficulty, and enables the operator, by the mere touch of a finger on an adjusting screw, to regulate the tension of the spring, and adapt his apparatus to the circumstances of the moment.

The main line, thus arranged with its delicate receiving magnet and its short recording circuit at each extremity, made no provision for intermediate or collateral stations. But, as it had been found desirable in practice to distribute the batteries, in which the electric fluid was generated, over different parts of the line, so as to reinforce the energies of the current in its progress, it was almost an obvious suggestion to connect at these several points a receiving magnet of adjustable character, either with the main line, or with the battery forming part of it, and to attach to this receiving magnet a local registering circuit, or a branch circuit leading to one or more collateral stations.

Such I understand to be Mr. Morse's *Local or Independent Circuit.* His patent of 1846, as re-issued in 1848, claims it in these words:

"The employment in a certain telegraphic circuit, of a device or contrivance called the receiving magnet, in combination with a short local independent circuit or circuits, each having a register and registering magnet or other magnetic contrivances for registering, and sustaining such a relation to the registering magnet or other contrivances for registering, and to the length of circuit of telegraphic line, as will enable me to obtain, with the aid of a main galvanic battery and circuit and the intervention of a local battery and circuit, such motion or power for registering, as could not be obtained otherwise without the use of a much larger galvanic battery if at all."

That the local or independent circuit, as we have described it, and as it is more accurately and perhaps more intelligibly set out by Mr. Morse in his specification, was original with him, cannot be seriously questioned. The devices referred to in the patents of Cooke and Wheatstone, and Davy are at best imperfect modifications of the combined series of Mr. Morse's first patent; one of them not improbably borrowed from it. The adjustable receiving magnet, the indispensable and characteristic element of the local circuit patent, no one has claimed but himself.

It is only to make the first approach to a controversy on this point, to prove to us that Professor Henry had as early as 1828 made the *intensity magnet*, with which the scientific world is now familiar—or that he afterwards, and before Mr. Morse's first application for a patent, had illustrated before his classes at Princeton, the manner in which one circuit could operate to hold another closed or to break it at pleasure—or that he had foreseen the applicability of his discoveries to the purposes of a telegraph. The question is not one of scientific precedence; and if it were, this is not the forum that could add to or detract from the eminent fame of Mr. Henry. It is purely a question of invention applied in a practical form to a specific use; and so regarded it admits but of a single answer.

In passing from the questions of originality and identity of invention, that have been raised in the cause, without a more detailed review of all the testimony, there is occasion perhaps for an explanatory remark. It is this: the decree of a Judge finds its appropriate and only justification in the facts proved before him, not in theories, however ingenious, or the less speculative inferences of other minds; and where the essential facts of a case are as clearly established as they are here, it would be unprofitable as well as painful perhaps to discuss the particulars of variance between the witnesses. There is no place in which the evidence of scientific men, upon topics within their own departments of knowledge, is more to be desired than in this Court, when sitting for the trial of patent causes; and the opinions also of such men, when duly supported by reasonings founded on ascertained fact, must of course be valued highly. But it is a mistake to suppose that even on a question of science, opinion can be dignified here or elsewhere with the mantle of authority. Still less can we allow it to avail us here, when it assumes contested facts, or volunteers to aid us in determining the import of written instruments.

These remarks are not dictated by a spirit of unkind or uncourteous commentary on the depositions before us. We know that when opinion is active, it is not always easy to limit its range. There is besides very much of accurate scientific history, and of just and well guarded deduction from it, in these two volumes of exhibits. But it must be confessed also, that there is to be found here and there not a little of imperfectly considered dogma, as well as something of doubtfully regulated memory—and it has seemed to us, in this case as well as in some others, that the toil and expense and excitement of litigation might have been moderated perhaps, if the appropriate tone and province of testimony had been more exactly understood by some of the witnesses.

The objections which have been taken to the terms of the re-issue of Mr. Morse's patent of 1846, may be answered by a simple reference to that part of our opinion, in which we have considered the arguments of the same character that were urged against the patent of 1840.

It is beyond controversy, that the Local Circuit Patent has been infringed upon at some of the stations of the respondents' line; and it is the opinion of the Court, that it is also violated whenever the Branch Circuit of Mr. Rogers is employed. We have not been able to see the asserted difference in principle between the two devices. Both are equally well described as Branch or as Local Circuits. They have the same purpose; they effect it by the same instrumentality, even in appearance, to a great degree; and they seem to vary only in this, that the one derives its electric fluid from a battery placed within the line of the main circuit, the other from a battery placed without it. The change may be for the better; or it may not:—if it be, it is patentable as an improvement; but it cannot be used without Mr. Morse's license, until after his patent has expired.

III. The third patent is for the Chemical Telegraph. We do not propose to enter on the discussion of this. The subject of it is clearly within the original patent of Mr. Morse, if we have correctly apprehended the legal interpretation and effect of that instrument. We will only say, that we do not hold it to have been invalidated by the decision of the learned Chief Justice of the District of Columbia on the question of interference. The forms of the two machines before him were not the same; and the leading principle of both having been already appropriated and secured by the Magnetic Telegraph patent of 1840, nothing remained but form, to be the subject of interference.

The counsel for the complainants will be pleased to prepare, for the consideration of the Court, the draft of a decree, in accordance with the prayer of their bill.

For the Journal of the Franklin Institute.

Remarks on the Propeller and Steam Engine of the War Steamer San Jacinto. By J. W. Nystrom.

As I have been kindly permitted in a few numbers of the Journal to express some of my ideas in relation to screw propellers, I will ask for room for the following: and I wish it to be distinctly understood by the readers of the Journal, that my remarks are not intended to be personal to Mr. Isherwood, but for the *interest of screw propelling steam navigation*, a subject which has received my sole attention for the last ten years.

In the article noticing the trial trip of the San Jacinto, on page 342, are two propellers, one four, and one six blades, which comparative proportions are, in my opinion, entirely opposite to what is proper for propelling.

If we take the pitch and length of the six bladed propeller, and give it to the four bladed one, and *vice versa*, give the pitch and length of the four bladed propeller to the propeller with six blades, they would make two well proportioned propellers.

In the article referred to, the number of blades is treated of as though it governed the slip, without any reference to what the number of blades depend on; we should rather say that *the slip governed the number of blades;* for instance, take a propeller 10 feet in diameter, with a proper pitch$=$25 feet, and length in the direction of the axis$=$4·5 feet, and make it with three blades; place this propeller on a vessel so proportioned that the slip will be about 30 per cent., and make an experiment; afterwards cut the propeller in two equal parts, by a plane at right angle to the axis, twist one of the two halves 60 degrees, we will have a six bladed propeller; or say we make a regular six bladed propeller with the same pitch and diameter as the one with three blades, but take only the length$=$2·25 feet; make another experiment with this six bladed propeller on the same vessel, we will obtain precisely the same result as with the three bladed propeller.

Again, let these two experiments be made on a larger or fuller vessel which causes a slip$=$40 per cent; we will find the three bladed propeller will make the best execution. Then let us make the two experiments on a smaller or sharper vessel, which causes a slip$=$20 per cent.; then we find the six bladed propeller to do best. Experiments that I know of, have been made with one two bladed, and one six bladed propeller; their lengths were carefully proportioned; the result from the two propellers were precisely alike; and the six bladed propeller has the advantage of taking up less room in the stern, and is stronger and safer.

The number of blades is also governed by the proportion of pitch and diameter. When the propeller is geared, a proper pitch is one and a half ($1\frac{1}{2}$), or twice (2) the diameter, according to the gear. In such instances the number of blades should not exceed four (4) for any slip.

The Scotch engineers take a very narrow pitch in proportion to the diameter; for instance, on the steamers City of Glasgow and City of Manchester, which propellers have three blades; but the pitch is not quite one and a half ($1\frac{1}{2}$) the diameter, when an American engineer would have taken the pitch two and a half ($2\frac{1}{2}$) the diameter; this makes considerable difference in the number of blades.

A formula or rules could be set up, but as there is seemingly so much obscurity regarding the *slip*, formula or rules would be of no use, but I hope there will come a time for them.

Slip.—Mr. Isherwood says, the slip on the propeller was 26·27 per cent. Is that possible? We challenge any chief engineer or propeller builder, to bring the slip down to 26·27 per cent. with a propeller of $14\frac{1}{2}$ diameter, and $42\frac{1}{2}$ pitch, the vessel being loaded to $15\frac{1}{2}$ feet draft of water.

Suppose the slip could be brought down to 26·27 per cent., there would be no difficulty in giving the propeller 50 revolutions per minute, then the speed will be

$$M=\frac{42{\cdot}5\times50\times0{\cdot}7373}{88}=17{\cdot}8 \text{ miles per hour.}$$

That is, from Halifax to Liverpool in

$$\frac{2508}{24\times17{\cdot}8}=5{\cdot}78 \text{ days.}$$

Then we may hope to cross the Atlantic in less than 6 days. See page 322 about slip; this formula 2, will give the slip very near, when the propeller is about

$$P=2\tfrac{1}{2}D$$

But when the pitch varies much from this proportion, there must be another rule for calculating the slip, and will be very nearly as follows:

$$S=\frac{2{\cdot}5}{D^3}\sqrt{\pi^2 D^2+P^2}\left(\text{ꝏ}^2+2\sqrt[3]{Q^2}\right)$$

For the meaning of letters see page 331.

When the San Jacinto is loaded to $15\frac{1}{2}$ feet draft of water, the displacement and greater section area will be about

$\text{ꝏ}^2=429$ square feet.
$Q=1900$ tons.
$D=14\frac{1}{2}$ feet.
$P=42\frac{1}{2}$ "

$$S=\frac{2{\cdot}5}{14{\cdot}5^3}\sqrt{3{\cdot}14^2\times14{\cdot}5^2+42{\cdot}5^2}\left(429+2\sqrt[3]{1900^2}\right)=37{\cdot}7$$

Or 38 per cent.

Which I think is the minimum slip of the propeller. If not taking the steam engine into consideration, there is entirely too much pitch on the propeller; but if the arrangement of the steam engine does not allow higher speed of the propeller, the only way to make it up is by the increased pitch; but I do not agree that the boilers cannot supply steam for less pitch and more revolutions. With less pitch the propeller runs easier, and there will be less slip, and the required quantity of steam will be precisely the same.

Mr. Isherwood says, that the slip is a measure of loss of effect; this is indeed an error. What loss of effect, then, should the American propellers have, compared with the Scotch propellers, as the slip of the former is 20 or 30 per cent. more than the slip of the latter, owing to the different proportions of pitch; but on a close examination of their performance, we will find the former is ahead of the said per centage in the economy of power.

But suppose the slip to be a measure of loss of power; then if there was no slip, there should be no loss of power, and if we finish the example per San Jacinto, we have the speed in statute miles per hour,

$$M = \frac{42{\cdot}5 \times 31}{88} = 15 \text{ miles per hour,}$$

but as there is no slip in the water, the propeller is of no use for propelling the vessel, it can as well be taken off, and the remainder will be 375.92 horse power, from the *steam engine, which will drive the vessel* 15 *miles per hour with no propeller ! ! !*

However, the loss of effect by slip should not be taken off from the total power developed by the steam. First, take off the per centage for all the frictions and working the pumps, and from the remainder, as a unity, take off the per centage for slip. Suppose all the frictions and working the pumps to be about 35 per cent, we have, per San Jacinto, $782 \times 0{\cdot}35 = 274$ horses, and $782 - 274 = 508$ actual horse power to propel the vessel; from that we take the per centage for the slip, or, $508 \times 0{\cdot}26 = 132$ horses which should be the loss of effect by slip, and $508 - 132 = 376$ horses, the useful effect which propells the vessel.

Friction and working the pumps, ...	=274	horses.
Loss by slip, ...	=132	"
Useful effect, ...	=376	"
Total effect from the steam,	=782	

That is, if the slip was only 26 per cent; if the slip is 38 per cent. the loss of effect should be $508 \times 0{\cdot}38 = 193$ horses, and useful effect only $508 - 193 = 315$ horses.

For the Journal of the Franklin Institute.

Trial Trip of the Steamer La Guayra. *By* B. F. ISHERWOOD, *Chief Engineer U. S. Navy.*

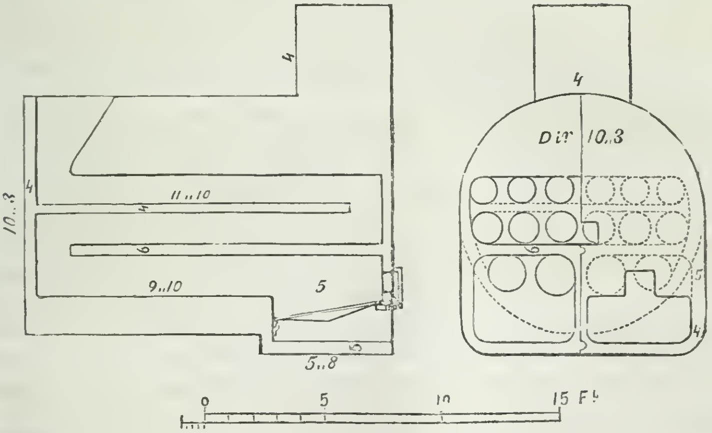
A small sea steamer intended to ply as a packet between La Guayra, South America, and the West India Island of St. Thomas, has recently been constructed at Baltimore, by Murray & Hazlehurst. At her late trial trip in Chesapeake Bay, the following results were obtained:

Hull.—Length on deck 132 feet, between perpendiculars 130 feet; breadth of beam 21 feet, over guards 34 feet; depth of hold 9 feet; burthen 250 tons; rigged as a three-masted schooner; draft forward 7½ feet, aft 7 feet.

Engines.—Two steeple engines, with four piston rods each. The advantage of this form of steeple engine over that with one piston rod, consists in allowing the crank to revolve within a few lines of the cylinder head; when one piston rod only is used, a cross head interposes between crank and cylinder head. Weight of engines, 75,741 lbs. Diameter of engines, 28 inches; stroke of piston, 4 feet; space displacement of both pistons per stroke, 34·208 cubic feet. There is one double acting air pump to both engines: diameter, 18$\frac{5}{8}$ inches; stroke of piston, 2 feet; space displacement of piston per stroke, 3784 cubic feet, or 1000 to every 9014 cubic feet of steam pistons' displacement. Steam valve, a long equilibrium slide.

Paddle Wheels.—Of the common radial kind, 15$\frac{3}{4}$ feet diameter. — paddles in each wheel; each paddle 5$\frac{1}{2}$ feet long by 18 inches broad. Dip of paddles, 30 inches.

Boilers.—One iron boiler, 15$\frac{1}{2}$ feet long, 10$\frac{1}{4}$ feet wide, and 11 feet high; containing 46·25 square feet of grate and 1010 square feet of heating surface. Weight of boiler, 31,779 lbs. The boiler has double return ascending flues; 4 lower flues, 2 of 19 and 2 of 21 inches diameter. First return 6 flues, 16 inches diameter; second return 6 flues, 15$\frac{1}{2}$ inches diameter. Area of lower flues, 8·749 square feet; of first return flues, 8·377 square feet; of second return flues, 7·904 square feet; of smoke pipe, 10·559 feet. Diameter of smoke pipe, 3$\frac{2}{3}$ feet; height above grates, 44 feet. Proportion of heating to grate surface, 21·838 to 1·000. Proportion of least calorimeter to grate surface, 1·000 to 5·851.



This boiler supplied the cylinders with 60 charges of steam per minute, of 20 pounds boiler pressure above the atmosphere, cutting off at $\frac{5}{8}$ths the stroke from the commencement; consuming 747 lbs. of bituminous coal per hour.

The space displacement of both pistons being 34·208 cubic feet, and the steam being admitted into $\frac{5}{8}$ths of this space before cutting off, or filling 21·38 cubic feet, to which add 0·62 cubic feet for clearance and nozzles, &c., making 22 cubic feet of steam used per stroke, and as the pistons make 60 strokes per minute, there would be used per hour 79,200 cubic feet of steam. Taking the steam pressure in the cylinders at 1·7 lb.

less than in the boiler, the total initial pressure in the cylinders would be 33 lbs.; and as the bulk of steam of that pressure to the water from which it is generated is as 810 to 1, there would be evaporated (79200 ÷ 810) 97·78 cubic feet of water. Taking the cubic foot of water at 64·3 lbs., there would be evaporated 6287·25 lbs. of sea water by 747 lbs. of bituminous coal, or 8·417 pounds of water per pound of coal. The trial trip was of so short duration, that there was no loss by "blowing off" to estimate for.

There was burned per hour per square foot of grate surface, 16.15 lbs. of coal; and there were evaporated per hour per square foot of heating surface, 6·223 lbs. of sea water.

Performance.—The vessel being brought to a draft of 7½ feet forward and 7 feet aft, the immersion of the lower edge of the paddles being 30 inches, made, with 30 revolutions of the wheels, 11½ statute miles per hour, in Chesapeake Bay. Steam pressure in boiler, 20 lbs. per square inch, cutting off at ⅝ths the stroke from the commencement.

The centre of reaction of the paddles moves through a space of 46·5 feet per revolution; the slip of the paddles will therefore be as follows:

46·5 × 30 × 60 = 83700 feet = speed of centre of reaction of paddles per hour.
5280 × 11½ = 60720 " = speed of vessel per hour.

22980 " = slip of centre of reaction of paddles per hour,

or 27·45 per cent.

The loss of labor by the oblique action of the paddles on the water, calculated as the squares of the sines of the angles of incidence, is 15·98 per cent.

The total losses of labor by the paddle wheel would then be 27·45 + 15·98, or 43·43 per cent.

The mean effective pressure in the cylinder throughout the stroke, taking the initial pressure at 1·7 lb. less than the boiler pressure, cutting off at ⅝ths the stroke from the commencement, and including the effect derived from the expansion of the steam in the nozzles, clearance, &c., and deducting 4 lbs. back pressure, would be 26·48 lbs.

The horses power developed by the engines would therefore be

$$\frac{(26{\cdot}48 \times 615{\cdot}75 \times 30 \times 4)\,2}{33000} = 118{\cdot}58.$$

The nominal power of the engines is 60 horses.

A Series of Lectures on the Telegraph, delivered before the Franklin Institute. Session, 1850–51. *By* Dr. L. Turnbull.

Continued from page 339.

Dr. Steinheil's Magnetic Telegraph.

This telegraph is composed of three principal parts. 1, A metallic connexion between the stations. 2, The apparatus for exciting the galvanic current. 3, The indicator.

1. *Connecting Wire.*—The so called connecting wire may be looked on as the wire completing the circuit of a voltaic battery extended to a very great length. What applies to the one holds good of the other. With

equal thicknesses of the same metal, the resistance offered to the passage of the galvanic current is proportional to the length of the wire. With equal lengths of the same metal, however, the resistance diminishes inversely with the section; but the conducting power of metals is very different. According to Fechner, copper conducts six times better than iron, and four times better than brass. The conducting power of lead is even lower, so that the only metals which can well vie with each other in their technical use are copper and iron. But now, though iron is about six limes as cheap as copper, it will be requisite to give the iron wire six times the weight of a copper one, to gain the same conducting power with equal lengths. We thus see, that as far as the expense is concerned, it comes to the same thing whichever of these metals is chosen. The preference will, however, be given to copper, as this metal is less liable to oxidization from exposure to the atmosphere. This latter difficulty may nevertheless be surmounted by simple means, namely, by galvanising it. It would even appear that the simple transmission of the galvanic current when the telegraph is in use, is sufficient to preserve the iron from rust; such at least is observed to be the case with the iron portion of the wire used for the telegraph here, and which has already been exposed in all weathers.

If the galvanic current is to traverse the entire metallic circuit without any diminution of intensity, the wire during its whole course must not be allowed to come into contact with itself; neither should it be in frequent contact with semi-conductors, inasmuch as a portion of the power called into action takes its course by the shortest way in consequence thereof, whereby the remotest parts are deprived of a portion of the power.

Numerous trials to insulate wires, and to conduct them below the surface of the ground, have led me to the conviction that such attempts can never answer at great distances, inasmuch as our most perfect insulators are at best but very bad conductors. And since in a wire of very great length, the surface in contact with the so-called insulator is uncommonly large, when compared with the section of the metallic conductor, there necessarily arises a gradual diminution of the force, inasmuch as the out and the home wire, although but slightly, yet *do* communicate in intermediate points. It would be wrong to think that this difficulty would be got over by placing the out and the home wire very far apart. The distance between them is, as we shall see in the sequel, almost a matter of indifference. And as we shall never succeed in laying down conductors that are sufficiently insulated beneath the surface of the ground, which is always damp, there is but one other course open to us, namely, leading the wire through the air. Upon this plan, it is true, the conductor must be supported from time to time; it is liable to be injured by the evil disposed, and is apt to suffer from violent storms, or from ice which forms upon it. As we, however, have no other method that we can avail ourselves of, we must endeavor by suitable arrangements to get the better of these, not immaterial, faults in the best way that we can.

The conducting chain of the telegraph erected here, consists of three parts: one leads from the Royal Academy to the Royal Observatory, at Bogenhausen, and back, and the total length of its wire is 32,506 feet. The weight of the copper wire employed amounts to 260 pounds. Both wires (there and back) are stretched across the steeples of the town, at a distance of four feet one inch. The greatest distance from support to support is 1279 feet: this is undoubtedly far too great for a single wire, inasmuch as the ice that forms upon it materially increases the weight of the wire itself, and considerably augments its diameter, so that it thus becomes liable to be torn asunder by high winds. Over those places where there are no high buildings, the connecting wire is supported upon tall poles forty or fifty feet long, which are let five feet into the ground, and to the top of which the wire is fastened to a cross bar. At the point where the metal rests there is simply a piece of felt laid, and the wire is made fast by twisting it round the wooden bar. The distance from pole to pole ranges between 640 and 650 feet; but this is far too great, for experience has shown that the wires become considerably stretched by high winds and other causes, and have, in consequence, had to be taken up more than once. All these evils would be got over by making the connexion by at least a triple strand of metal, and not by a single wire, supporting it at intervals of 300 feet, and giving it a tension not exceeding one-third of what it will bear without giving way. This, however, in the experimental telegraph erected here, was not practicable, for reasons into which we cannot enter.

The conducting wire thus mounted, is by no means completely insulated. When, for example, the circuit is broken at Bogenhausen, an induction shock given in Munich ought to produce no galvanic excitation whatever in the parts of the chain then disconnected. Gauss's galvanometer, however, even then gives indication of a weak current; measurements indeed go to show that this current goes on increasing as the point at which the interruption of the stream is made recedes from the inductor. The absolute amount of this current is not constant. Generally it is strongest when the weather is damp. When there are heavy showers of rain, it may be fairly said to be five times as strong as when the weather is settled dry. At moderate distances of a few miles, this small loss of power is of almost no importance, and that the more as the construction of the inductor places currents of almost any strength we choose at our command. When the distance, however, amounted to upwards of 200 miles, the greatest part of the effect would be dissipated. In such cases much greater precaution must be taken with regard to the points of support of the metallic circuit.

When thunder storms occur, atmospheric electricity collects on this semi-insulated chain as upon a conductor, but the passage of the galvanic current is not at all affected thereby. An occurrence may be mentioned here as a warning for the future. During a severe thunder storm on the 7th July, 1838, a very strong electric spark darted at the same instant through the entire conducting chain, and there was simultaneously produced at the indicator, that is fitted up in my room, a sound like the cracking of a whip. At the same time the lower toned bell of the indicator emitted a sound owing to the deflexion of the needle, and the blow was so hard that the points on which the magnetic bar plays were injured. The same phenomenon was observed also at one of the other stations. As the deflecting power of frictional electricity is very inconsiderable with respect to magnets, the above occurrence indicates the presence of a vast quantity of electricity. It can only have arisen from the electricity of the earth having at that moment made its way to that collected in the wire. Whether this was brought about through the lightning conductors in the neighborhood, or the imperfect insulation of the points of support, cannot be well made out.

Quite recently I made the discovery, that the ground may be employed as one-half of the connecting chain. As in the case of frictional electricity, water or the ground may with the galvanic current form a portion of the connecting wire. Owing to the low conducting power of these bodies, compared with metals, it is necessary that at the two places where the metal conductor is in connexion with the semi-conductor, the former should present very large surfaces of contact. Taking water, for instance, to conduct two million times worse than copper, a surface of water proportional to this must be brought in contact with the copper, to enable the galvanic current to meet with equal resistance, in equal distances of water and of metal. For instance, if the section of a copper wire is 0·5 of a square line, it will require a copper plate of 61 square feet surface in order to conduct the galvanic current through the ground, as the wire in question would conduct it. But as the thickness of the metal is quite immaterial in this case, it will be always within our reach to get the requisite surfaces of contact at no great expense. Not only do we by this means save half the conducting wire, but we can even reduce the resistance of the ground below what that of the wire would be, as have been fully established by experiments made here with the experimental telegraph.

A second portion of the conducting chain leads from the Royal Academy to my house and observatory in the Lerchenstrasse. This conductor is of iron wire; its length, there and back, is 5745 feet, and it is stretched over steeples and other high buildings, as has already been described. Lastly, a third portion of the chain, running through the interior of the buildings connected with the Royal Academy, leads to the mechanical workshop attached to the cabinet of Natural Philosophy. It is composed of a fine copper wire, 958 feet long, let into the joinings of the floor, and in part imbedded in the walls. These three portions together compose a line, returning into itself, and into which the apparatus for generating the galvanic current, and also the indicator, are inserted.

2. *Apparatus for Generating the Galvanic Current.*—Hydro-galvanism, or the galvanic current generated by the action of the voltaic pile, is by no means fitted for traversing *very long* connecting wires, because the resistance in the pile, even when many hundred pairs of plates are employed, would be always inconsiderable compared with the resistance offered by the wire itself.

The principal disadvantage, however, attendant on the use of the pile or trough apparatus, is the fluctuations of their current, joined to the circumstance of their becoming very soon quite powerless, and requiring to be taken to pieces and put together again. The extremely ingenious arrangement of Morse is likewise subject to this inconvenience. (All these inconveniences have been obviated by Morse's local circuit and the improved form of battery employed since Steinheil's experiments.—T.) All this, however, is got over when one, to generate the current, has recourse to Faraday's important discovery of induction, that is to say, by moving magnets placed in the neighborhood of conducting wires. The better way, however, is, not to move the magnets as Pixii does in his electro-magnetic apparatus, but rather to give motion to the multipliers placed close to a fixed magnet. The arrangement that Clarke has given to the multiplier is the one which, with some modifications, has been adopted. Assuming on the part of our readers a general knowledge of the principles of the apparatus, we here confine ourselves to explaining how it has been adapted to purposes of telegraphic intercourse.

The magnet is composed of 17 horse-shoe bars of hardened steel. With its iron armature its weight is about 74 lbs., and it is capable of supporting about 370 lbs. Between the arms of the magnet there is fastened a piece of metal, supporting in its centre a cup provided with adjusting screws, and which serves as a support for the axis of the coils of the multiplier. The coils of the multiplier have in all 15,000 turns of wire. A metre (3 feet 3·3708 inches English) of this wire weighs $15\frac{1}{2}$ grains, and it is twice bespun with silk. Its two ends, which are insulated, are passed up through the interior of the vertical axis of the multiplier, and then terminate in two hook-shaped pieces, as may be seen in Plate xv. figs. 8 and 9. In order to secure perfect insulation, the vertical axis, fig. 8, was bored out hollow. Into this hole there are let in from above two semicircular rods of copper, which are prevented touching by a strip of taffeta fastened between them with glue; and these again are kept from touching the metallic axis by winding taffeta round them. In each of these little strips of metal there is, above and below, a female screw cut. In the lower holes small metal pins are screwed in, to which the ends of the multiplier are soldered securely on. While in the upper holes, as may be seen distinctly in figs. 9 and 10, there are iron hooks screwed in. These hooks therefore form the terminations of the multiplier wires of the coils of the inductor. They here turn down, fig. 15, into two semicircular cups of quicksilver, that are separated by a wooden partition. From these cups of quicksilver there proceed connexions, J.J, figs. 8 and 13, towards the wires, and they therefore may be considered as forming part of the chain. The quicksilver, owing to its capillarity, stands at a higher level in these semicircular cups than are the partitions, so that the terminal hooks of the wires of the multiplier pass over these partitions without touching them when the multiplier is made to turn on its axis. One sees that the hooks thus are brought into other cups of quicksilver at every half turn of the multiplier, in consequence of which the galvanic current preserves its sign as long as the multiplier is turned in one direction, but it changes its sign on the motion being reversed. This commutation, which it may be remarked may be established without the use of mercury, by the contact of strips of copper that act like springs, is found to answer completely. There are besides two other arrangements which we must not allow to pass unnoticed.

The galvanic current, as we shall see in the sequel when treating of the indicator, should only be permitted to be in action during as short a period as possible, but during that interval should have the greatest intensity we can command. The terminal hooks of the wires dip into the quicksilver only at the place where it forms pools that advance towards each other at the centre, and where the current is at its greatest intensity, see figs. 13, 14, and 15. Fig. 15 shows the position that the inductor has when the terminal hooks first dip into the cups. In all other positions of the inductor it should however form no part of the chain, otherwise the signals made at the other stations will be repeated by its own multiplying wire; and this becomes of the more moment the greater the resistance in the inductor is. In order therefore to cut off the inductor when in any other position than shown at fig. 15, there is a wooden ring adapted to the axis of rotation of the inductor, see figs. 11 and 12. This ring is encircled with a copper hoop, and into this latter two iron hooks are screwed. These hooks dip down into the semicircular cups of quicksilver, as shown at fig. 14. At the moment, however, that they are passing across the wooden partition, the hooks of the inductor, which are at right angles to them, dip into the cups. When the hooks of the multiplier are in contact with the quicksilver, the connexion with the hooks for diverting the current is broken. In every other position the connexion through the hooks of the multiplier is interrupted, while it is established through the others; whence it naturally follows that the current, on being transmitted from any other station, passes directly through the latter hooks, or, in other words, crosses directly from one quicksilver cup to the other, and is not forced to traverse the wire of the inductor for that purpose. In order to put the inductor in motion without trouble, there is a fly bar terminating in two metal balls fastened horizontally on to its vertical axis, (annexed cuts,) figs. 39 and 40. To prevent the quicksilver being scattered about, owing to the motion of the hooks as they dip into it when the multiplier is turning rapidly, a glass cylinder is fitted on to this part of the apparatus, fig. 1. At every half turn is seen the passage of the spark, as the hooks of the multiplier leave their cups of quicksilver.

Fig. 39.

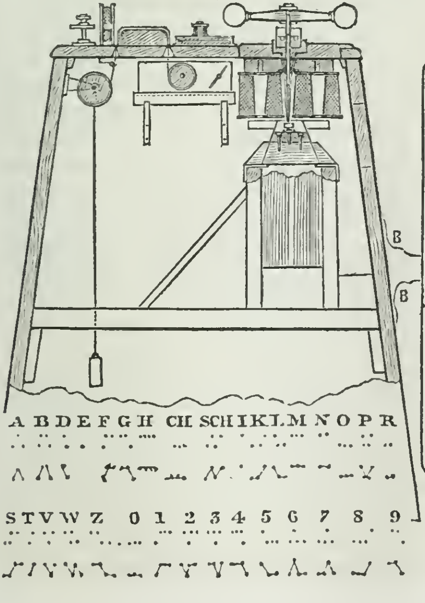
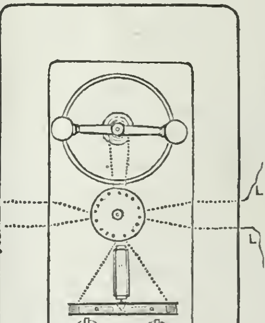

B
B
A B D E F G H CH SCH I K L M N O P R
S T V W Z 0 1 2 3 4 5 6 7 8 9

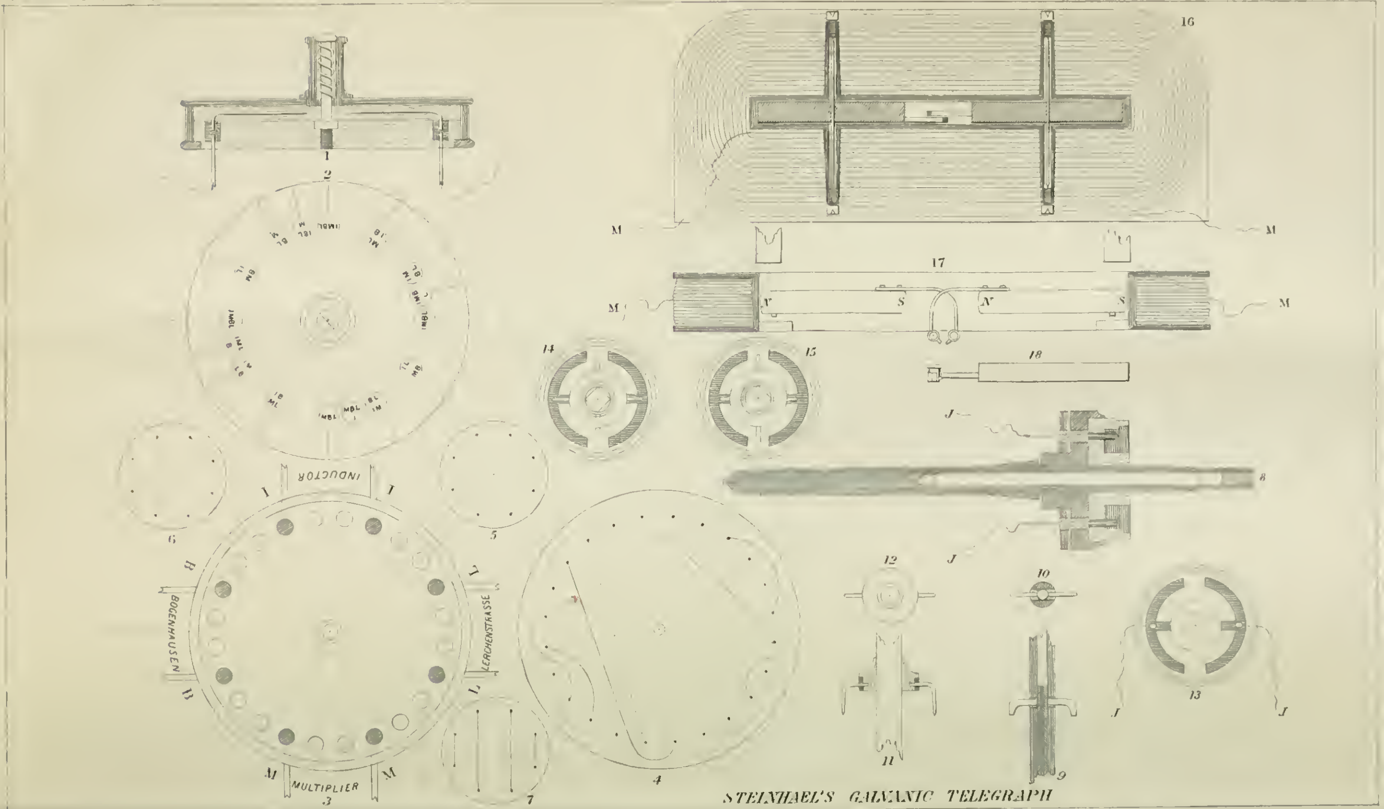
Fig. 40.



If we choose to give up the phenomena of these sparks, a thing noways necessary to the employment of the instrument as a telegraph, the inductor will admit of a far more simple construction. It will then merely be necessary to place the commutator directly above the anker, and to let the axis of rotation pass farther up in the neck, in the direction of the fly bar. It then becomes unnecessary to bore the axis out, but the ends of the multiplier are at once fastened by twisting on to two plates of copper, and these copper plates are let into a wooden ring directly opposite each other. The wooden ring is placed upon the vertical axis, and made fast to it by clamps. Externally this ring is, in addition to the above-mentioned plates, provided with an arc of copper let into it, which acts as a contact-breaker, and two ends of the chain that the current has to traverse have the form of permanent springs, that keep pressing against the wooden rings directly opposite each other. By this means, with this arrangement also, the ends of the inductor are in metallic communication with the chain only during a small portion of each revolution, while during the rest of the time the connecting arc brings the ends of the chain into direct contact. This construction, in which quicksilver is entirely dispensed with, is, on account of its greater simplicity and durability, preferable to the arrangement first described. The apparatus of the stations at Bogenhausen and in the Lerchenstrasse are thus constructed.

3. *The Indicator.*—We have shown in the preceding paper, that our aim is so to employ the current developed by the inductor and led through the conducting chain, that when passed across magnetic bars that are delicately suspended, it may cause them to be deflected, as was discovered by Œrsted. These deflexions, if we wish to give the signals in quick succession, must follow each other with the greatest rapidity, and should therefore be powerful. This points out to us the size we should give the magnetic bars we wish to deflect. They must not however be made too small, as in that case the mechanical force arising from their deflexion is not strong enough to be directly applied to striking upon bells, or any other similar purpose. The deflexions are, as is well known, taking the force of the current to be the same, the stronger, the greater the number of turns in the multiplier, or, in other words, the oftener the wire is led along the magnetic bar. The size of the diameter of the separate turns, as we know, only exerts an influence inasmuch as it adds to the entire length of the connecting wire. The indicator therefore is a multiplier, whose two ends connect it with the conducting chain, and within which the bar to be deflected is placed. It must be borne in mind, that the thinner the wire of the multiplier is, the larger its coils are; and the more turns they make, the greater is the resistance to the current throughout the entire chain.

Figs. 16 and 17, Plate xv., represent the vertical and horizontal sections of an indicator containing two magnets, movable on their vertical axis, and which from their construction are applicable both to striking bells and also to noting down a type composed of dots. Into the frames of the multiplier, which are made of soldered sheet brass, fig. 16, there are soldered two smaller cases for the reception of the magnets, and which allow of the free motion of their axes. Above and below they have threads cut in them for the reception of four screws in holes, on the ends of which



STEINHAEL'S GALVANIC TELEGRAPH

the pivots of the axes turn. By means of these screws the position of the bars may be so regulated that their motion is perfectly easy and free. In the frames of the multiplier there are 600 turns of the same insulated copper wire as was employed for the inductor. The commencement and the end of this wire are shown at M M, fig. 16. The magnetic bars are, as the figure shows, so situated in the frame of the multiplier, that the north pole of the one is presented to the south pole of the other. To the ends which are thus presented to each other, but which, owing to the influence they mutually exert, cannot well be brought nearer, there are screwed on two slight brass arms supporting little cups, figs. 17 and 18. These little cups, which are meant to be filled with printing ink, are provided with extremely fine perforated beaks that are rounded off in front. When printing ink is put into these cups, it insinuates itself into the tube of these beaks, owing to capillary attraction; and without running out forms at their apertures a projection of a semi-globular shape. The slightest contact suffices therefore for noting down a black dot. When the galvanic influence is transmitted through the multiplying wire of this indicator, both magnetic bars make an effort to turn in a similar direction upon their vertical axes. One of the cups of ink would therefore advance from within the frame of the multiplier, while the other would retire within it. To prevent this, two plates are fastened at the opposite ends of the free space that is allowed for the play of the bars, and against which the other ends of these bars press. Only the end of one bar can therefore start out from within the multiplier at a time, the other being retained in its place. In order to bring the magnetic bars back to their original position as soon as the deflexion is completed, recourse is had to small movable magnets, whose distance and position is to be varied till they produce the desired effect. This position must be determined by experiment, inasmuch as it depends upon the intensity of the current called into play.

If this apparatus be employed for producing two sounds easily distinguishable to the ear by striking on bells, it will be right to select clock bells or bells of glass, both of which easily emit a sound, and whose notes differ about a sixth. This interval is by no means a matter of indifference. The sixth is more easily distinguished than any other interval; fifths and octaves would be frequently confounded by those not versed in such matters. The bells are to be supported on little pillars with feet, and their position with respect to the bars, and likewise their distance from them, is to be determined by experiment. The knobs let into the bar that strike on the bells must give the blow at the place which most easily emits a sound. These hammers, however, are not to be too close to the bells, as in that case a repetition of the signal can easily ensue. A few trials will soon get over this difficulty. If the indicator is to write down the signals, a flat surface of paper must be kept moving with a uniform velocity in front of the little beaks above mentioned. The best way of doing this is to employ very long strips of the so-called endless paper, which is to be wound round a cylinder of wood, and then cut upon the lathe into bands of the suitable width. One of these strips of paper must be made to unwind itself from a cylinder, pass close in front of the cups, run along a certain distance in a horizontal position, so that the dots noted down may be read off, and lastly, wind itself up again on to a second cylinder. This second cylinder is put in motion by clock work, the regularity of whose action is insured by a centrifugal fly-wheel. A longitudinal section of the entire arrangement is shown at fig. 39, (p. 411.) Fig. 40 represents it as seen from above. At the corners of the frame over which the ribbon of paper is led, there are placed two movable rollers, to diminish the friction. This frame moreover admits of being advanced towards the cups or withdrawn from them, so that the most proper position to give it can be ascertained by experiment. It is evident that the same magnetic bars cannot be at once employed for striking bells and for writing, the little power they exert being already exhausted by either of these operations. But to combine them both, all we have to do is to introduce a second indicator into the chain. By thus increasing the number of the indicators, the loudness of the sounds of the bells can be augmented at pleasure; this can, however, only be done at the cost of an increased resistance in the chain. In order that this may be increased by the indicator as little as possible, it would in future be better that its coils should be made of very thick copper wire, or of strips of copper plate.

The above description will enable those who are familiar with such subjects to construct the apparatus for themselves. We have yet to add a few words upon

The Way of putting the Apparatus together.—Fig. 39, (p 411,) represents the longitudinal section of a pyramidal table, standing on the floor of the room, and containing the whole apparatus. Fig. 40 shows the same as seen from above. The wires from Bogenhausen, those from the Lerchenstrasse, the ends of the indicator, and the wires from the quicksilver cups of the inductor, or, in other words, the two ends of its multiplier, all meet together at the centre of the table, as seen at fig. 40. They are here brought into connexion with eight holes filled with quicksilver, made in a disk of wood, as shown at fig. 3, Plate xv. The course that the current we call forth will take depends upon the respective connexion of these eight holes with each other. For instance, supposing them to be connected together by four pieces of bent copper wire, as shown at fig. 3, the current would pass through the whole apparatus, and also the entire chain. Establishing, however, the connexion as shown at fig. 6, would cut off the Bogenhausen station, and would at once transmit the current direct from the inductor, through the multiplier of the indicator and through the Lerchenstrasse station. Supposing this figure turned round 180 degrees, we should have the Lerchenstrasse station cut off, and the current would pass through Bogenhausen. A third system of connexions is shown by the copper wires represented in fig. 7. In this position of the sketch, the inductor and the multiplier would be in direct communication, while the two stations at Bogenhausen and in the Lerchenstrasse would be cut off. But by turning this figure 90 degrees, we should connect these two stations, while we broke off the station in the Academy. Copper wires, serving to establish these three systems of connexion and the combinations, are laid down upon the under surface of the wooden cover of the commutator, as seen at fig. 4. There are 24 wires projecting downwards from this lid. Only eight of them, however, ever come into use at once, so that there must be sixteen other holes made in the lower disk of wood, for the reception of the wires not in use, and having no quicksilver poured into them. It is thus in our power to direct the course of the current as we choose, and the systems concerned are indicated upon the upper surface of the cover of the commutator by engraved letters, see fig. 2, Plate XV.; this cover containing the different modifications of the systems of connexion, as shown at fig. 4. Changing the position of this cover round the central pin springing from the table, enables us to vary the direction of the current in any manner we like. The use of quicksilver cups in the commutator may of course be replaced by conically turned copper pins. This has indeed been done at the Lerchenstrasse and the Bogenhausen stations.

We shall conclude by a few remarks upon

The Application of this Apparatus to Telegraphic Communication.—We know from what has preceded, that at every half turn of the fly-bar from right to left, one of the bars is deflected. I have so connected the terminations of the wires, that every time this movement is repeated the high toned bell should be struck at all the stations. Standing at the side B B, and turned towards the indicator, one immediately perceives the beak imprint a dot upon the ribbon of paper as it moves along. The intervals of time between the successive repetitions of this sign, are represented by the respective distances between the dots that follow in a line upon the paper. On turning the fly-bar from left to right towards the operator, the deep toned bells ring, and the second ink cup marks down a dot upon the paper as before; not, however, upon the same line with the former dots, but upon a lower one. *High* tones are therefore represented by the *upper* dots, and *low* tones by the dots of the *lower* line, as in writing music. As long as the intervals between the separate signs remain equal, they are to be taken together as a connected group, whether they be pauses between the tones, or intervals between the dots marked down. A longer pause separates these groups distinctly from each other. We are thus enabled, by appropriately selected groups thus combined, to form systems representing the letters of the alphabet or stenographic characters, and thereby to repeat and render permanent at all parts of the chain, where an apparatus like that above described is inserted, any information that we transmit. The alphabet that I have chosen represents the letters that occur the oftenest in German by the simplest signs. By the similarity of shape between these signs and that of the Roman letters, they become impressed upon the memory without difficulty. The distribution of the letters and numbers into groups consisting of not more than four dots, is shown at fig. 39, (page 411.)

On the Explosion of the Locomotive "Minnesota," on the Philadelphia and Reading Rail Road.

"DEAR ——: "*Reading, Pa., October* 27, 1851.

"In reply to your favor of the 24th inst., I would state,

1st. It is impossible to say, with certainty, what was the height of the water at the instant of giving way of the crown sheet.

The engine "Minnesota" was in charge of a very good and careful man, who states that he had *shut off his pump* a short time previously, when going down grade, after having found water in his top cocks; upon which point he is positive.

2d. In contradiction to the above statement, there are some indications of the crown sheet and top row of tubes having been very hot, from the present appearance of both; but what degree of heat had been reached it is difficult to say.

3d and 4th. No bridge bars were used, stay bolts being inserted in their place, fig. 1 being the form of the firebox.

Fig. 1.

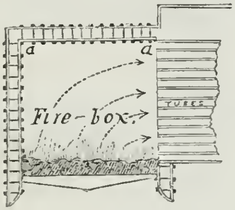
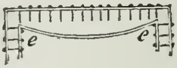
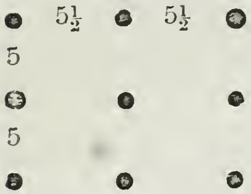


Fig. 2.



The lower crown sheet, from *d* to *a*, gave way, by stripping the screw threads and rivet heads of all the stay bolts between it and the top sheet, and sank down about two to three inches, forming a dish, as in fig. 2, without breaking or tearing in the least the boiler iron, which is of excellent quality. The stay bolts are $\frac{3}{4}$-in. round iron, and are from 5 to $5\frac{1}{2}$ inches apart, fig. 3; water way between crown sheets 4 inches. I think the explosion was caused by a combination of these causes; too great a distance between the stay bolts for proper strength; the under heads of the stay bolts not being sufficiently riveted, and the heating of the crown sheet, from low water in the boiler.



The engine is now at Reading, but is uninjured except as described, in the sinking of the crown sheet. It is but eleven months old, and has run but 18,000 miles. It was built by Ross Winans, of Baltimore, and weighs $22\frac{1}{2}$ tons of 2240 lbs., with coal fuel and water.

The engine emptied itself of the water and steam in the boiler through the stay bolt holes in the lower crown sheet, instantly killing the fireman, who was standing opposite the fire doors, and slightly scalding one of the brakemen, on the tender, who was just in the act of getting off the engine.

For the Journal of the Franklin Institute.

On Holophotal Lights for Light-Houses. *By* THOMAS STEVENSON, Esq., *Civil Engineer.*

Observing from some parts of the transactions of the Franklin Institute which were sent to me last month, that a Member brought forward at the meeting on 20th December, 1849, a claim for the invention of my Holophotal prisms for Light-Houses, I beg leave to bring the following facts under notice:

1st, I communicated my invention to the Secretary of the Royal Scottish Society of Arts, on the 30th March, 1849, and in proof of the due receipt of the communication, I received from the Secretary an acknowledgment, of which the subjoined is a copy:

"Edinburgh, March 31, 1849.

"Thomas Stevenson, Esq., C. E.

"DEAR SIR:—I have received your letter of 30th inst. with another tracing of a form of light, in which catadioptric zones are employed for parallelizing the diverging rays, both horizontally and vertically.

"I presume you are not yet ready with the models, so that you do not wish your papers read, till you give me further notice.

"Yours, very truly,

(Signed,) "JAMES TOD, Sec'y R. S. S. A."

2d, On the 30th April, 1849, I described at a public meeting of the Royal Scotch Society of Arts, the invention among several others, and in particular, along with my description of the Holophotal system generally.

3d, On the 15th of October, 1849, the proceedings of the Society at the meeting above referred to, were published in the Edinburgh Evening Courant Newspaper, from which I have extracted the following minute:

"Another new form of Light-house apparatus was also described, by which the whole sphere of rays can be parallelized by means of a hemispherical reflector placed behind the light, and an annular lens, and a series of concentric totally reflecting glass zones, also placed in front, and receding from the lens back to the reflector. These zones are also new in themselves, as they have the property of parallelizing divergent rays, not only in a vertical plane like the zones in Fresnels fixed lights, but also in every plane whatever."

About the same time it appeared, to my own knowledge, in the Practical Mechanics' Journal, and the Civil Engineer and Architect's Journal of November, 1849.

4th, In Mr. Alan Stevenson's rudimentary practice, (one of Mr. Weale's series which was published Dec. 21st, 1849, there is *inter alia*, a description of the Holophotal prisms.

5th, In July, 1850, a complete set of rings on this principle, 23·2 inches in diameter, were shown lighted in the Assembly Rooms, Edinburgh, at a Conversazione of the British Association, which met at Edinburgh that year.

6th, The Light of Pedra Branco, near Singapore, has been fitted up with nine Holophotal Reflectors, in which the prisms were placed; and also the Harbor Light at Pultneytown, in Caithnesshire, which was lighted on 21st July last.

From these facts you will observe that the priority of the invention of these prisms belongs to me, and that my account of them was brought before the public at a meeting of the Royal Scottish Society of Arts, nearly eight months before the date of your meeting. I have, therefore, to request that you will bring this communication under the notice of the Institute at your early convenience.

Edinburgh, October 15, 1851.

For the Journal of the Franklin Institute.

Experiments upon two Hydraulic Motors, with Prony's Friction Brake, showing the comparative power between an Over-shot Wheel and a Jonval Turbine, made for Troy, N. Y., by Mr. E. GEYELIN.

1st. *Experiment upon an Over-shot Wheel.*—Head and fall, 27 feet; number of revolutions of shaft where the friction brake was applied, 80.

Total weight on lever, . . .	331·50	
Weights raised including the lever, . . .		366·00
Weight of lever, ...		34·50
		331·50

Circumference of lever, 71·47 feet. Result 57·84 horse power.

2d. *Experiment upon a Jonval Turbine.*—Head and fall, 19 feet $1\frac{1}{2}$ inches; number of revolutions of shaft where the friction brake was applied, 196.

Weight raised, ...	46·50 lbs.
Weight of lever, ...	34.50 "
Part cut off at the end of arm, ...	1·00 "
Total weight,	82·00

Circumference of lever, 71·47 feet. Result, 34·81 horse power.

Power transmitted by a 25 feet diameter over-shot wheel, with a fall of 27 feet, to a shaft running at speed of 80 revolutions, (to which the brake was applied,) 57·48 horse power.

Estimated loss of effective power on increasing the speed from 80 to 180 revolutions, 2·48 horse power, ...	57·48 2·48
Power transmitted to the rollers of the engines,	55·00 horse power.
As the overshot wheel is supposed to have been overloaded, I add to it five per cent of its effective power, to bring it into its best condition, or, 2.75 horse power; making the total power of the overshot wheel in its best condition, with the rollers run. at a speed of 180 rev.,	2·75 57·75 horse power.

By actual experiment the effect of an overshot wheel, using the same quantity of water, diminishes in the ratio from one to one-third, when the fall diminishes from one to one-half.

If an over-shot wheel	25 feet diameter gives .	57·75 horse power,
One of	12·5 feet diameter will give	19·25 "
	37·5 feet.	77·00

An overshot wheel of 18·75 feet diameter, gives 38·50 horse power; if, therefore, an over-shot wheel of 18·75 feet diameter gives 38·50 horse power, an over-shot wheel of 17 feet $1\frac{1}{2}$ inches diameter, which would be applicable to a fall of 19 feet $1\frac{1}{2}$ inches, using the same amount of water, will give 35·15 horse power.

Performance by trial of the Jonval Turbine, using the same amount of water as the above mentioned over-shot wheel, with a fall of 19 feet $1\frac{1}{2}$ inches, 35·81 horse power. From observations made by Mr. Tompkins, on the part of Messrs. Manning, Peckham, & Howland, (owners of both the over-shot wheel and Jonval Turbine,) and E. Geyelin, on the night of October 30th, 1851, the movable wheel of the Jonval Turbine was found one quarter of an inch smaller in diameter than the cylinder it revolves in; consequently the wheel ought to be enlarged $\frac{3}{16}$ of an inch in diameter.

The loss of water through the excess of clearance between the movable wheel and cylinder existed on July 24, 1851, the time the above mentioned experiments were made. The circumference of the movable wheel being 10 feet, and the clearance between the wheel and cylinder, $\frac{3}{32}$ of an inch more than requisite, there was 11·25 square inches through which the water passed without producing any effect. Actual area of the openings of discharge in the wheel, 127·80 square inches: Consequently, the power to be added to the power formed by the experiment, as that due to the water escaping through the excess of clearance, will be the 11·35 part of 34·87 horse power, or 3·06 horse power.

Actual power named by trial, ...	34.81	horse power.
Additional power that can be obtained, . . .	3·06	"
Total power of Turbine when properly constructed,	37·87	"

By these results it will be observed that the total power of the Jonval Turbine will be 37·87 horse power, when an overshot wheel in its best conditions will only give 35.15 horse power. *The advantage of the Jonval Turbine over the over-shot wheel, using the same amount of water, is consequently seven per cent.*

Jonval Turbine Office, Philad., Nov. 18, 1851.

For the Journal of the Franklin Institute.

On Foucault's Pendulum Experiments.

I see by an article in your number for November, that the reason of the apparent rotation of the plane of vibration of a pendulum, as shewn by Foucault's very interesting experiment, is not yet clearly seen by every body. Will you permit me to occupy a little space in your Journal, for the purpose of setting forth my own method of looking at this matter; I do not attempt any demonstration, enough of these having already been given for those familiar with mathematics, but merely to illustrate the physical reason of the phenomenon, by facts and in language familiar to all.

Imagine yourself, then, on a morning in summer standing at the foot of a plumb line and having the cardinal points of the compass marked by known objects on the horizon, watching the rising of the sun. This luminary rises to the north of east, and as he passes above the horizon, moves apparently in a path which inclines southwardly, until at length he is seen at some distance above the horizon, and due eastward from the point of observation. His motion continues towards the meridian and southwardly, until at noon he is seen due south, and from this time, his apparent path turns more and more to the north, until he is found due westward, and afterwards sets at a point north of the west point of the horizon, and if he could be perceived after this time, he would be seen moving toward the north and east, until at midnight he would be seen in the plane of the meridian, whence he would move southward and eastward, until he again crossed the horizon and rose, at the same place as on the day before, (no allowance being made for his motion in declination.) The sun, therefore, appears to move, not simply from east to west, as we loosely express ourselves, but in an inclined path which carries him from the east by the south to the west and north. But as the sun is himself stationary, this apparent motion must be in fact attributed to the horizon, which therefore appears to move in an opposite direction from the east by the north to west and south, around the vertical line through the place of observation represented by the plumb line, at the foot of which the observer is supposed to be stationed. If now, this plumb line be made a pendulum, by starting it into vibration in any direction, say from west to east, no reason can be assigned why the plane of its vibration, (which is a purely mathematical and not a physical quantity,) should partake of this motion of the horizon. The horizon will therefore, as it were, rotate under it, or the pendulum will appear to move, as the sun does, from the east by the south to west.

This illustration is founded upon a well known fact, viz: the apparent displacement of the points of the horizon in reference to any heavenly body, in a circular direction from east by the north, around the vertical line through the place of observation. As it is a fact demonstrable by observation, it is not necessary to explain the reason of it, but if there be any one who desires its explanation, he will easily find it by reflecting that the axis of the earth, around which the motion actually takes place, is inclined (in all positions except one) to the horizontal north and south line to which, as an axis, we naturally refer this motion—and that in consequence, the plane of the motion which is perpendicular to the true axis, is necessarily oblique to that to which we refer it, whence this apparent double motion of the heavenly bodies. To an observer at the equator, the north and south line is parallel to the axis; hence the motion is perpendicular to this line, and this apparent rotation of the points of the horizon does not occur; hence also, at the equator there will be no apparent motion of the pendulum. To an observer at the pole, on the contrary, a north and south line is perpendicular to the axis, and the motion is, therefore, parallel to this axis, or the sun appears to move around the horizon without changing his distance from it, (neglecting, always, the change in declination, produced by the annual motion of the earth in its orbit.)

But it will be objected to my explanation on the part of those, who have not been able to grasp the phenomena, that the sun in the illustration, or what is the same thing, the points of the horizon in reference to the sun, go over the whole circle in twenty-four hours, in every position upon the earth's surface, while it is asserted that in reference to the pendulum, they in the same time describe an arc, less in proportion as the latitude of the place of observation is less. This difference arises from the fact that in reference to the sun or any heavenly body, the axis of the circle thus described, (which is the vertical line drawn through the point of observation,) is displaced, as is shewn by the elevation of the sun above the horizon; this increases the apparent angular motion by the displacement of the centre of the arc described; while in the case of the pendulum, which is carried along with the vertical in this movement, no such relative displacement takes place, and the arc described by the pendulum must be less than the arc described by the sun at the same point of observation, in proportion as this displacement of the centre is greater; that is, in proportion as the latitude is less, (for the displacement is the diameter of the circle which the point of observation describes in the daily motion of the earth, which is greater at the equator, and being less as the latitude increases, disappears at the poles.)

As, therefore, this displacement disappears at the poles, the difference between the apparent motion of the sun and the pendulum will vanish, and the pedulum will describe its circle in twenty-four hours, while, as we have clearly shewn at the equator, neither the sun nor pendulum have any apparent motion in reference to the points of the horizon; and as the sun's motion is always the whole circle in 24 hours, that of the pendulum will be less in this, in a certain proportion to the latitude of the place of observation. STUDENT.

For the Journal of the Franklin Institute.

Reply to T. Stevenson, Esq., C. E., respecting his claim to the Invention of Holophotal Apparatus for Light-Houses.

The letter of Mr. Stevenson published in the present number of this Journal, page 416, will require but a brief reply, as the members of the Franklin Institute are aware of the facts. Mr. S. evidently supposes that my invention of rings, or zones of glass, presenting in their section a curvilinear triangle, and adapted to reflecting the light in one direction, was first mentioned to the Franklin Institute, at their monthly meeting on the 20th December, 1849. The invention was not then brought forward as any novelty, having been frequently described to many of the members and others, several seasons before, by the undersigned, as is expressly mentioned in the proceedings just referred to.* The design was to discuss the various forms in which the plan might be useful, and the adaptations of which it is capable. The idea of such rings was thus rendered familiar to many, long before the date assigned by Mr. S., as the period of his publication. In fact, no merit was claimed for an idea so very obvious. It occurred to me to inquire if a ring of glass, in a fixed dioptric light, (produced by the revolution of a curvilinear triangle round a vertical axis,) projects the light in one uniform horizontal plane, or cylinder having the same axis—what would be the effect if a ring should be formed by the revolution of such a triangle round a horizontal axis? The result would necessarily be to project the incident light parallel to such axis. I presume that the same very obvious thought has occurred to many others. At what precise period this occurred to me, I do not remember. The rings I refer to are those placed in the *anterior* half of a dioptric apparatus. In relation to those invented by Mr. Stevenson, which constitute the *posterior hemisphere*, and which reflect the light to the original point of emission, and thence to the lens, I have never claimed any part of *this*, by no means obvious, but very ingenious invention, which confers great credit on Mr. Stevenson, to whom we are much indebted for it; and he will observe that I expressly described it to the meeting of the Franklin Institute, Sept. 19, 1850, (see vol. xx, 3d series of this Journal, page 236,) as his; and he, I am happy to be informed, has additional merit in carrying it into actual practice. G. W. SMITH.

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* See also, the proceedings of the Franklin Inst. Feb. 15, 1849, and March 15, 1819.

Translated for the Journal of the Franklin Institute.

Physics.—Upon the hypotheses relative to Luminous Ether, and upon an experiment which seems to demonstrate that the motion of Bodies changes the velocity with which light is propagated within them. By M. H. FIZEAU. (*Extract by the Author.*)

Numerous theories have been proposed to account for the phenomenon of aberration on the system of undulations. Fresnel, in the first place, and more recently Messrs. Doppler, Stokes, Challis, and several others, have published important articles on this subject; but it appears that none of these theories have received the entire assent of natural philosophers. Indeed, in the absence of certain knowledge of the properties of luminous ether, and of its relations to ponderable matter, it has been found necessary to make hypotheses, and amongst those which have been proposed, there are several more or less probable, but none which may be considered as proved.

These hypotheses may be reduced to three principal ones. They have reference to the condition in which the ether existing in the interior of a transparent body is to be conceived.

Either the ether is adherent, and as it were, attached to the molecules of a body and consequently partakes of the motion which may be given to that body:

Or, the ether is free, independent, and is not carried along by the body in its movements:

Or, finally, by a third hypothesis, which partakes of the other two, a portion only of the ether is free, the other portion is fixed to the molecules of the body, and that alone moves within it.

This last hypothesis, which we owe to Fresnel, was started with the view of accounting at the same time for the phenomenon of aberrations, and a celebrated experiment of Mr. Arago, by which it is shown, that the motion of the earth is without influence upon the refraction which the light of the stars undergoes in a prism.

We can examine the value, which, for each of these hypotheses, is to be given to the velocity of light in bodies, when we suppose those bodies in motion. The value of these velocities may be changed by the fact of the motion.

If we suppose that all the ether is carried along with the body, the velocity of the light will be augmented by the entire velocity of the body, supposing the ray to be projected in the direction of the motion. If the ether is supposed to be free, the velocity of the light will not be changed.

Finally, if only a portion of the ether is carried along, the velocity of the light will be augmented, but by a fraction only of the velocity of the body, and not by the totality, as in the first hypothesis. This consequence is not as evident as the preceding ones, but Fresnel has shown that it may be supported by very probable mechanical considerations.

Although the velocity of light is so enormous in comparison with the velocities which we are able to give to bodies, yet we possess, at the present day, means of observation so delicate, that it has been thought possible to determine by a direct experiment, what is really the influence of the motion of bodies on the velocity of light.

We owe to Mr. Arago a method founded on the phenomenon of interferences, which is capable of indicating the smallest variation in the indices of the refraction of bodies. The observations of Messrs. Arago and Fresnel, upon the difference of refraction which exists between dry and moist air, have shown the extraordinary sensibility of this means of observation.

It is by adopting the same principle, and joining the double tube of Mr. Arago to the apparatus of two conjugate telescopes which I had employed for the determination of the absolute velocity of light, that I have been enabled to study directly in two mediums, air and water, the effects of the motion of a body on the light which traverses it.

I shall endeavor to point out, without the aid of a drawing, what was the course of the light in this experiment. From the focus of a cylindrical lens, the solar rays entered almost immediately the first telescope by a lateral opening near its focus—a transparent mirror, whose surface was at an angle of 45° to the axis of the telescope, threw them by reflection, in the direction of the object glass.

After passing out from the object glass, the rays, having become parallel to each other, arrived at a double slit, each opening of which corresponded with the entrance of one of the tubes. Thus a very narrow pencil of rays penetrated into each tube and traversed its whole length. (1·487m. = 4ft. 10in.)

The two pencils of light, still parallel to each other, reached the object glass of the second telescope, were refracted, and by the effect of that refraction united at its focus; there they encountered the surface of a mirror perpendicular to the axis of the telescope, and underwent a reflection, which returned them towards the object glass. But, by the effect of the reflection, the pencils had changed their route, so that that which was before to the right passed to the left after the reflection, and vice versa. After having again traversed the object glass, and thus become once more parallel to each other, they entered a second time the tubes; but as they were inverted, that which had passed through one of the tubes in going, passed through the other tube on its return.

After their second passage through the tubes, the two beams again traversed the double slit, re-entered the first telescope, and, passing through the transparent glass, interfered at its focus. There they formed, by their mutual action, fringes of interference, which were observed with an eyepiece provided with a scale of divisions at its focus.

It was necessary that the fringes should be very wide for the purpose of permitting the appreciation of small fractions of the width of a fringe. I found that this result was obtained, whilst still preserving a great intensity of light, by placing before one of the slits a thick glass, inclined in such a manner as to show the two slits by the effect of refraction, as though they were nearer to each other than they were in reality; one may thus give to the fringes variable dimensions, and choose that which is most suitable for the observations. The double passage of the light has for its object, the increase of the distance passed over within the medium in motion, and, moreover, to compensate entirely for the influence of an accidental difference of temperature, or of pressure in the two tubes, whence might result a displacement of the fringes that would be confounded with the displacement which the motion might produce, and would render the observation uncertain.

Indeed, it is very easy to see that, by this arrangement, each point, situated on the path of one of the pencils, is equally on the path of the other, so that a change in the density at any point whatever in the passage acts in the same manner on the two rays, and can not consequently have any influence upon the position of the fringes. The fact that the compensation is total, was verified by placing a thick glass before one only of the two slits, or indeed by filling with water one only of the tubes, the other being filled with air. Neither of these experiments caused the slightest change in the position of the fringes. Relative to the motion, we see, on the contrary, that the two beams are submitted to opposite influences.

If we suppose, in fact, that in the tube placed on the right the water flows towards the observer, the beam coming from the right will have passed through the tube in the direction of the motion, whereas the beam coming from the left will have passed through it in a direction contrary to the motion.

By making the water in the two tubes flow, at the same time, in directions opposed to each other, we perceive that the effects should be added. This double current being produced, we may reverse the direction, at the same time, in each tube, and the effect should again be doubled.

All these movements of the water were produced in a very simple manner, each tube being in communication by means of two branches placed near its extremities, with two glass reservoirs, on which pressure was alternately exercised by means of compressed air. Under this pressure the water passed from one reservoir to the other through the tube whose two extremities were closed by glasses. The interior diameter of the tubes was 5·3 m. (2·087 inches,) their length 1·487 m. (4 feet 10 inches;) they were of glass.

The pressure under which the flow of the water took place was perhaps more than two atmospheres. The velocity was calculated by dividing the volume of water passed over in one second by the area of the section of the tube. I should say for the purpose of anticipating an objection which might be made, that the greatest care was taken to avoid the effects of accidental movements which the pressure and shock of the water might have produced. Thus the two tubes and the reservoir, where the motion of the water took place, rested on supports independent of the other portions of the apparatus, and particularly of the two telescopes, and it was therefore the tubes only which could receive an accidental movement; but both reason and experience have shown, that the movements or bending of the tubes alone were without influence on the position of the fringes. The result of the observations made, is as follows:

When the water is set in motion its fringes are displaced, and according to the direction in which the water moves, the displacement takes place to the right or to the left.

The fringes are displaced towards the right, when the water flows from the observer in the tube situated on his right, and towards the observer in the tube situated on his left.

The fringes are displaced towards the left, when the direction of the current in each tube is opposite to that just indicated.

With a velocity of the water equal to two metres per second, the displacement is already very perceptible; with velocities of from four to seven metres, it becomes perfectly susceptible of being measured after having verified the existence of the phenomenon. I endeavored to ascertain its numerical value with as much exactitude as was possible, calling, a *simple* displacement, that which is produced when the water previously in repose was just set in motion, and a *double* displacement, that which is produced when the motion has just been changed to a contrary motion. We find by a mean deduced from nineteen observations, differing but slightly from each other, 0·23 for a simple displacement, which gives 0·46 for a double displacement, the width of the fringe being taken for unity. The velocity of the water was 7·069m. per second.

This result is afterwards compared with those which are deduced by calculation from the divers hypotheses relative to the ether.

On the supposition that the ether exists free, and independent of the motion of bodies, the displacement should be nothing.

On the hypothesis that the ether is united to the molecules of bodies, so as to partake of their motion, the calculation gives for the double displacement, the value of 0·92. The observation gave a number one-half smaller, or 0·46.

On the hypothesis that the ether is partially carried along, according to the theory of Fresnel, the calculation gives 0·40, that is to say, a number very approximately that which has been found by observation. And the difference between these two values would have been very probably still less, had it been found possible to introduce into the calculation of the velocity of the water, a correction necessarily neglected for want of data sufficiently precise, and depending on the unequal velocity of the different liquid filaments: in estimating the value of this correction in the most probable manner, we see that it tends to augment a little the theoretic number, and to approximate still more its value to the result of the observation.

An experiment similar to that just reported, had been previously made with air in motion, and I had ascertained *that the motion of the air produces no sensible displacement in the fringes.* Under the circumstances in which this experiment was made, and with the velocity of 25 metres per second, which was that given to the motion of the air, we find in the hypothesis, that the ether was carried along, that the double displacement should have been 0·82.

According to the hypothesis of Fresnel, the same displacement should have been but 0·000465, that is to say, altogether insensible. Thus the apparent immobility of the fringes, with the air in motion, is altogether in accordance with the theory of Fresnel.

It was after having verified this negative fact, and in the endeavor to explain the divers hypotheses relative to ether, in such a manner as to make them accord at the same time with the phenomenon of aberration, and with the experiment of M. Arago, that it appeared to me necessary to admit with Fresnel, that the motion of bodies occasions a change in the velocity of light, and that this change of velocity is greater or less for different mediums, according to the energy with which these mediums refract light, so that it is considerable in bodies of great refractive power, and very feeble in those which refract less, as the air.

It results from this, that if the fringes were not displaced when the light traversed air in motion, we should on the contrary have a very sensible displacement, in making the experiment with water whose index of refraction is much greater than that of air.

An experiment, for which we are indebted to M. Babinet, published in the IX. volume of the *Comptes Rendus de l'Academie des Sciences*, appeared to be in contradiction with the change of velocity in conformity with the law of Fresnel. But in considering the circumstances of this experiment, I have remarked the existence of a cause of compensation which should render insensible the effect due to the motion; this cause arises from the reflection which the light undergoes in this experiment; in fact, we can demonstrate, that when two rays have relative to each other a certain difference of phase, this difference is altered by the effect of the reflection from a mirror in motion; now in calculating separately the two effects in the experiment of M. Babinet, we find that they have values sensibly equal, and contrary signs.

This explanation renders still more probable the hypothesis of the change of velocity, and an experiment made in water in motion appears to me proper in every respect to decide the question with certainty.

The success of this experiment seems to me to necessitate the adoption of the hypothesis of Fresnel, or at least of the law which he has discovered to express the change of the velocity of light by the effect of the motion of bodies; for although, should this law be found true, it would be very strong proof in favor of the hypothesis of which it is but a consequence, perhaps the conception of Fresnel will appear so extraordinary, and in some respects so difficult to admit, that still further proofs, and a profound examination on the part of mathematicians may be demanded before adopting it as the expression of the reality of things.

For the Journal of the Franklin Institute.

Exposition of Foucault's Experiment. By J. S. Brown.

In the exposition of Foucault's experiment, on page 354 of the Journal, an error was inadvertently inserted. It was there said that the deviation of the pendulum between 45° and 90° "is slower in the first, and faster in the last part of each half revolution." It should have read, slower in the first part of the first, and last part of the last, and faster in the last part of the first, and first part of the last half revolution.

I will here add, that between 0° and 45°, the deviation of the pendulum in the last half of each revolution of the earth is first *against the sun*, and then back, the reverse of its movements in the first half of the revolution. But this would be readily inferred without special notice.

The exemplifications given in my first communication were all on the supposition that the pendulum should commence oscillating in the meridional plane. The same phenomena would be exhibited if the original plane of oscillation should be in any other point of the compass, as is readily perceived by considering that the same conditions continue, with the simple variation of the original direction of the generating planes in the sphere, while their relative directions remain the same. The angles which the tangents of the great circles, in which the two generating planes cut the earth, make with the respective axes of those planes, are the variables dependent on the direction of the original plane of oscillation. And these angles are invariably the same with both generating planes, whatever their original direction. When the original direction is north and south, these angles are nothing; when east and west, 90°, as the direction varies from the meridional.

The slight irregularity arising from the spheroïdity of the earth, or any other incidental disturbance, was not there considered, being foreign from the object proposed in the exposition.

Washington, D. C., Nov. 25, 1851.

Description of a New Chain, invented by M. Sisco.*

Experiments have been made at Woolwich Dockyard with a new description of chains, submitted by M. Sisco, a Frenchman. The new chains are made of common hoop-iron of the breadth required, and wound on a reel by machinery into an oval shape, and to the same breadth as the outer surface, which is rounded off after the whole has been brazed in passing through a furnace of molten metal. The usual test of an iron chain for naval service of two inches in diameter is 70 tons strain, but many links break with the application of far less power, and yet the other parts of the chain are found qualified to pass the required ordeal. M. Sisco's chain of two inches broad and two inches thick, with stays in the centre of each of the two links, was placed in the testing-frame, attached to a testing-chain of $2\frac{1}{2}$ inches in diameter, and on the hydraulic power being applied one of the links was lengthened $\frac{5}{8}$-inch and the other $\frac{1}{3}$-inch when it reached a strain of 110 tons, and the $2\frac{1}{2}$-inch testing-chain broke off in two places when the strain reached 114 tons. The hoop-iron chain had some openings in one of the links, which had been imperfectly brazed, but it did not appear to have been otherwise defective. One link of the same dimensions, 2 inches thick and 2 inches broad, was afterwards placed in the testing-frame, and when a strain of 70 tons was applied to it had lengthened $\frac{1}{12}$-inch; with 80 tons, $\frac{1}{8}$-inch; with 100 tons, $\frac{3}{16}$-inch; with 110 tons, $\frac{1}{4}$-inch; with 115 tons, $\frac{5}{16}$-inch; and when it resisted 120 tons strain it was considered advisable not to continue the strain, as it was so great as to loosen the stone frame on which the machine rested, and liable to damage other parts of the powerful frame of the machine. The strain applied on this occasion was one ton more than had ever been previously applied, and the hoop-chain was only slightly opened on one side. When inquiries were made as to the price at which the hoop chains could be supplied, it was stated that they would not cost more per cwt. than the common chains, although their holding powers were so much greater in proportion.

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* From the London Architect for November, 1851.

On the Passage of the Steamer Atlantic from New York to Liverpool. By John Hampson, C. E.*

The following account of the number of revolutions made by the engines of the United States Mail Steamer *Atlantic*, on her August trip, from New York to Liverpool, and calculation of the slip of the wheels, may be acceptable to your readers.

Whole number of revolutions reported by the engineer, 217,681
Distance from port to port, 3050 miles.
Effective diameter of wheels, reckoning from centre to centre of float, floats 27 inches deep, 33·33 feet.

$$\text{Hence } \frac{33{\cdot}33 \times 3{\cdot}141 \times 217{,}681}{6116} = \quad . \quad . \quad . \quad 3728{\cdot}26 \text{ miles.}$$

Distance presumed to have been run (at the least,) 3050

Miles slip 678·26

equal to $18\frac{18}{100}$ per cent.

London, Sept. 29, 1851.

FRANKLIN INSTITUTE.

Proceedings of the Stated Monthly Meeting, November 20, 1851.

S. V. Merrick, President, in the chair.
John F. Frazer, Treasurer.
A. S. Roberts, Recording Secretary, P. T.

The minutes of the last meeting were read and approved.

Donations were received from The Chemical Society, London; B. H. Latrobe, Esq., Baltimore, Maryland; Thos. Ewbank, Esq., and Gen. T. Lawson, Surgeon Gen. U. S. Army, Washington, D. C.; J. R. Tyson, H. C. Baird, Blanchard & Lea, John F. Frazer, Horatio Stephens, Wm. Firmstone, and Edward Miller, Philadelphia.

The Periodicals received in exchange for the Journal of the Institute were laid on the table.

The Treasurer's statement of the receipts and payments for the month of October was read.

The Board of Managers and Standing Committees reported their minutes.

The Committee on Exhibitions presented their report on the late Exhibition.

Resignations of membership in the Institute (53) were read and accepted.

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* From the London Artizan for October, 1851.

New candidates for membership in the Institute (97) were proposed, and the candidates (32) proposed at the last meeting were duly elected.

On motion, the following awards were made in accordance with the Report of the Committee on Exhibitions, presented this evening:

To Messrs. Cornelius & Co., of Philadelphia, *The Franklin Gold Medal*, for the novelty and beauty of the designs, and for excellence of workmanship in chandaliers, brackets, and candelabras, shown at the late exhibition.

To Messrs. Lammot & Son, of Delaware County, Pa., the usual *Gold Medal*, for the very superior quality of bed tickings, shown by them.

To Messrs. Griswold & Co., of Troy, New York, the usual *Gold Medal*, for Velvet and Tapestry Carpeting, which the judges say are equal to the best foreign productions, and superior to any domestic of the same character that have come under their notice.

Dr. Rand exhibited several specimens of crystalized slags, which were presented to the Institute by Mr. Horatio Stephens, of the Allentown Iron Works; they consisted of silicates of lime, &c., and were of the form of cubes, prisms, &c., very perfect and of great beauty.

Prof. J. C. Cresson also presented to the notice of the Institute, a specimen of crystalized pig iron of white color, but of great purity, from Cooper & Co's. Furnace, New Jersey; presented to the Cabinet of the Institute by Mr. Wm. Firmstone.

Self-acting Railroad Switch, by Mr. W. Foster, of Trenton, was brought before the meeting, and a model exhibited by his son, and its action explained.

G. W. Smith called the attention of the members to two beautiful designs for carpets; one of a lion excited general admiration by its elegance, and the great beauty of finish and coloring of the eye and other details. They were of English manufacture, and the under surface was of gum elastic. Prof. Cresson made some interesting remarks in regard to the history of this form of carpet, and explained the great care in preparing the colors, so that compressions may be employed. Mr. Smith observed that the only objection to their use was, the exclusion of air from the surface of the floor, so as to cause it to rot.

Mr. Smith called the attention of the Institute to the destructive effects of anthracite vapor on the mortar, and even the action on the bricks so as to destroy them, producing a very dangerous condition of the chimneys of our residences. He attributed the effect to the sulphurous acid (which results from the combustion of nearly every species of coal) forming sulphuric acid in the pores of the bricks and mortar, and also to the hydrochloric acid and the ammonia. A chimney of J. P. Wetherill, Esq's. had been efficiently protected by a coating of wax, and Mr. S. thought a coat of tar might be used. Dr. Wynne inquired of Mr. Smith, if the same results were produced by semi-bituminous coal, when Mr. Smith referred him to Isaac Lea, Esq., who remarked that it arose from the sulphurous acid generated, and which was produced by all the varieties of coal containing sulphur. Mr. Lea suggested the use of a handsome clay cap, well burned, which he had seen in a recent visit to Cincinnati.

Prof. Cresson found from close observation, that previous to rain, the streaks of white matter on the surface of the bricks, were nitrate of lime produced by the decomposition of the mortar. Prof. Frazer suggested the use of glazed bricks, with the proper kind of mortar, or those well burned chimney tops of Mr. Harrison, which were exhibited during the last display of our Institute.

Dr. Rand thought that the result might also be produced by the use of wood in air-tight stoves, now so extensively used, by the generation of pyroligneous acid.

Dr. Turnbull observed that there were two important agents which had not been brought forward, namely, the use by builders, of sand and gravel containing a large quantity of alumina, obtained from sand and gravel pits in the neighborhood of our city, the sulphurous acid coming in contact with alumina in the mortar, and forming a sulphate of alumina which is washed out of impure and improperly made mortar, and thus loosening the brick. The true remedy was to obtain well washed sand and gravel, and make a proper mortar, so as to hold the bricks firm, for builders find that it requires more hydrate of lime to make a proper mortar with good sand. Another evil was the large quantity of nitric oxide, and when in air, nitrous acid, which combining with even the very best mortar, forms nitrate of lime, and every shower washes it down, and thereby destroys the cement which unites the bricks.

Prof. J. C. Cresson explained to the meeting, the great difficulty experienced at the Philadelphia Gas Works from the spontaneous combustion of large quantities of the bituminous coals from Virginia, which contain iron pyrites, the first notice of which was the slow distillation of benzole, and after a time it burst out into a flame, so that there would be a space of 50 feet in flames at one time. He had constructed an apparatus, by which he could force any amount of carbonic acid into it from a pipe eight inches in diameter, so as to fill the whole space with it, but although the flame was extinguished for the time, it would again break out, with as much force as ever, and burn even with more rapidity. They ad also employed large trunks, so that the air could be sent throughout the whole mass, but they had experienced no advantage from this arrangement, and when the fire had commenced to burn, it most generally continued with more violence near the trunks which conducted the air.

There was, therefore, no resort but to flood the whole mass of coal, and thereby damage a considerable quantity of it, rendering it unfit for the purposes of gas making.

Mr. Youmans exhibited a well designed chemical chart, and explained it to the meeting. He stated that nearly all the natural sciences could be taught to children at school; and why could we not teach chemistry? He also stated that by the use of a certain number of the elements painted in colors, with lines connecting the most important compounds and diagrams of the sign, and as near as possible the color of the body, or the color of the salts. Children could learn enough of chemistry to make it an object for teachers to introduce it even into the ordinary school course.

Mr. I. Lea in some elegant remarks gave a short biographical sketch of the life and writings of our deceased fellow member, Richard C. Taylor, Esq., one of the most accurate geologists who has ever examined the extensive coal fields of Pennsylvania, and who has written a book which contains more information on the subject of coal, than any other work in the English language. In his youth he was thoroughly educated, in the art of mining, both practically and theoretically, which fitted him for the study of geology, so that an opinion from him was of great value. He was born in England, but for the latter part of his life, was a resident of Philadelphia, and had gone completely over, and surveyed the entire coal fields of our state.

COMMITTEE ON SCIENCE AND THE ARTS.

Report on the Explosion of a Steam Boiler at I. P. Morris & Co.'s Factory.

The Committee on Science and the Arts, constituted by the Franklin Institute of the State of Pennsylvania for the Promotion of the Mechanic Arts, to whom was referred for examination, the "Explosion of a Steam Boiler," at the Factory of Messrs I. P. Morris & Co., at Richmond, Philadelphia County, Penna.—Report:—

That the boiler in question was of a cylindrical form, 5 feet in diameter and 16 feet long, having a fire-box at one end, from which three main flues, the largest of which was 20 inches in diameter, extended to the smoke-box, from which twelve return flues, 6 inches in diameter, carried the products of combustion to the chimney. Near the end of the boiler there was a steam dome 4 feet in diameter, which was placed over an opening of the same size in the shell of the boiler. The iron of which the boiler was made, was of the best quality, 0·3 inches in thickness. This boiler was intended for the use of a steamboat, and was to be used under 100 lbs. pressure. The parties who ordered it required that it should first be tested under a pressure of 150 lbs. Upon this trial the fire was kept up, until the safety-valve lifted under a pressure of 148 lbs; an additional weight was then added sufficient to give the requisite pressure of 150 lbs, and after a few moments, the experiment was considered as satisfactory, and directions were given to open the fire-doors; at this moment the explosion took place, killing one of the persons present, and severely injuring two others, one of whom has since died.

The boiler was torn into at least three pieces, by fractures perpendicular to the axis,—one of which, (the fire-box end,) was thrown forward, and came in contact with two large Cornish boilers which were lying in front of it, indicating by its effects upon them the terrific violence with which it had been projected. The waist of the boiler was torn from the steam dome, ripped open, and flattened out upon the wharf where it lay, while the steam dome and other portions, were thrown high into the air, and fell into the Delaware river, whence they have not been recovered. The main flue was also separated from the rest and thrown into the dock, whence it was afterwards recovered and found flattened, but apparently not collapsed by the pressure of the steam.

In seeking to account for this explosion, we may in the first place remark, that there appears no reason whatever, to suspect the existence of a low water-level. The experiment had been but a short time in progress, no water or steam had been lost, except that which was blown off at the safety-valve, nor was any pump in connexion with the boiler by which cold water might be thrown upon an exposed and overheated surface. This, then, the most common of all causes of explosion of steam boilers, cannot be reverted to, to explain this one.

Nor is there any reason to suspect carelessness or recklessness on the part of those in charge of the experiment, nor negligence or mistake in the calculation of the pressure on the safety-valve. The boiler was at the time under the charge of perfectly competent persons, who were under no excitement, had no inducement to rashness, nor were under circumstances likely to lead to overhaste, and whose lives were, as the result too sadly proved, exposed in the event of an explosion.

The committee submitted to the proof of the breaking apparatus, pieces of the iron taken from the edges of the fractures, and the results shewed that the iron was of good quality. The following are the breaking weights per square inch of section, of these pieces:

Iron taken	from the	side	of the boiler;	with the fibre,	67·200 lbs;	across the fibre,	67·200 lbs.
"	"	shell	"	"	50·400	"	56·000 "
"	"	flues	"	"	53·760	"	54·880 "

If from these data, and the diameter and thickness of the shell of the boiler, we calculate its strength, and compare it with the effort exerted upon the shell by a pressure of 150 lbs. per square inch, we shall find that after making all possible allowances, a simple cylindrical shell of such diameter and thickness, and made of such materials, would have been fully equal to the strain brought upon it. But when we consider the effect of the large opening made into the steam dome, we shall see that the strength of the cylinder was very materially diminished, and probably brought below what was necessary to resist the strain upon it.

It will be easily seen that the effect of such an opening thus covered must be to bring a greatly increased strain upon its edge where it intersects the upper line of the shell, while the dome itself gives but little aid in resisting this pressure, and if the deformation of the shape or a tear of the iron should be the consequence, the other results of the explosion might easily follow. The committee deem this defect of form to be so manifestly sufficient to account for the explosion that they do not think it necessary to advert to any other, but strongly call the attention of boiler builders and engineers to the importance of avoiding such large openings in the shell in future.

In conclusion, they take this opportunity of returning their thanks to I. P. Morris & Co., for the facilities which they so freely afforded them for a thorough examination.

By order of the Committee.

William Hamilton, *Actuary.*

Philadelphia, Nov. 13, 1851.

BIBLIOGRAPHICAL NOTICE.

Medical Lexicon.—A Dictionary of Medical Science; by Robley Dunglison, M. D. *8th Edition. Revised and greatly enlarged.* Philadelphia: Blanchard & Lea, 1851.

In acknowledging the reception of, and in directing attention to, this elaborate Medical Dictionary, we can only reiterate the general voice of the profession, for which it is especially intended, in proclaiming it to be the most extensive and useful work of the kind ever published in this country.

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